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ABSTRACT

This manual presents a 10-day lesson plan for day camp and after-school program leaders. The activities and experiments described in the manual focus on nutrition and space exploration. Topics covered by the lesson plan and specific projects include: (1) gravity; (2) food spoilage; (3) model rocket building and launching; (4) the basic food groups; (5) weightlessness; (6) food preservation and dehydration; (7) high- and low-fat foods; (8) the influence of sensory perception on food likes and dislikes; (9) dehydrated and rehydrated foods; and (10) germs and bacteria. Each experiment and activity description provides the instructor with background information; a list of needed materials; an explanation of the actual experiments, activities, and games; and a discussion of what children should learn from the project. An appendix provides a list of the characteristics of 9- to 11-year-olds; a pre- and posttest for the child participants; National Aeronautics and Space Administration (NASA) descriptions of living and working in space; NASA facts on the Space Shuttle and its food systems; questions and answers on irradiated food; a bibliography of 11 books on space for 9- to 11-year-olds; and a discussion of the benefits of food dehydration. (MDM)

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Leader's Manual
4H-EFNEP 4150

Blue Sky Below My Feet

Daycamp & After School Programs

9 to 11 year olds

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Leader's Manual

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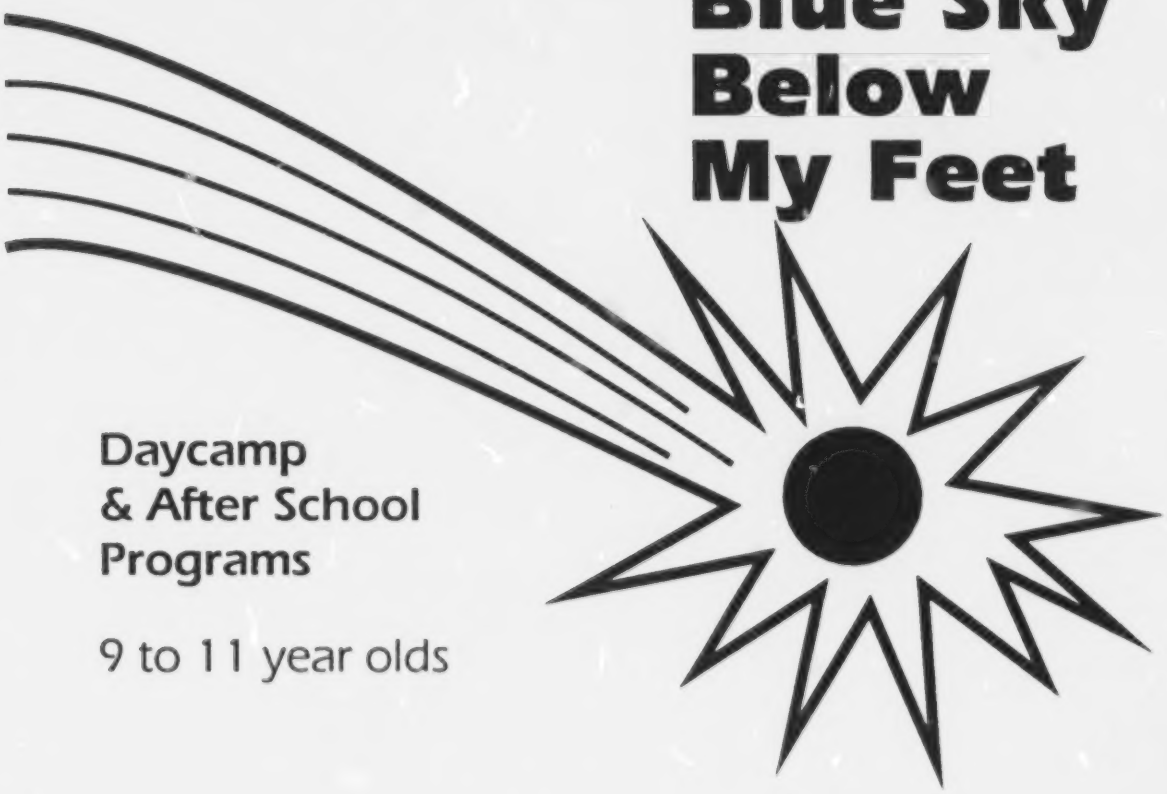
Blue Sky Below My Feet



Daycamp & After School Programs

9 to 11 year olds

University of California,
Cooperative Extension
4-H Expanded Food & Nutrition
Education Program

BLUE SKY BELOW MY FEET

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BLUE SKY BELOW MY FEET *

Sample LESSON PLAN for Day Camp and Afterschool Programs — Day 1

Ten 90 minute sessions; fifteen hours total teaching time.

Topic	Activity (Time)	Objectives for Members	Key Points for Leaders
Day 1	(15 min.) Registration		• Use membership cards as name badges. • Display ***Blue Sky*** posters, resources, etc. (Refer to National 4H Council order form.)
Get acquainted	•*"Flying Saucer"* game (15 min)	• Learn names of campers. • Explore the effects of gravity. • Learn that gravity affects our lives in many ways.	
Introduction to Gravity	•Discussion (5 min.) •*"Forces"* video (15 min.) •Discussion (10 min.)	• Understand the basic principles of gravity. • Explore how gravity affects our lives. • Understand how gravity affects the Space Shuttle.	• Discuss questions in Leader's Handbook, pp. 14-16. • Identify key points for members. • View first half of *"Forces in Space"* video. Stop after 15 min.
Introduction to Gravity	•*"Gravity & Me"*–Activities: Choose one or more (15 min.) (15 min.) *"Hula Hoops & Much More"* (15 min.)	• Gain an understanding of the basic principles of gravity. • Explore the effects of gravity.	

*This curriculum was pilot tested in Yolo County with 150 youth, ages 8-12 years, in 1987 and 1988. Day camp groups had 30 members at a site with 3 Vista volunteers and one coordinator.

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Sample LESSON PLAN for Day Camp and Afterschool Programs — Day 2

Topic	Activity (Time)	Objectives for Members	Key Points for Leaders
Day 2			
Gravity	*"Space Tag"* game (15 min.)	• Understand why handkerchief (or any object) falls to earth.	
Bacteria on earth and on space	*"Germs, Boogers & Bacteria"* experiment (15 min.)	• Describe why it is important to wash hands before touching/preparing food. • Identify the role of bacteria in food spoilage. • Make scientific observations and record those observations.	Discussion • Bacteria is a cause of food spoilage. • Bacterial growth is affected by the environment: contaminants (dirty hands), temperature, light, moisture, etc. • Washing hands with soap and warm water is important. Sliced sourdough bread works best for this experiment. Place 'clean' and 'dirty' slices in individual plastic bags with a small amount of water (10 drops). Store in a cool, dark place.
Rocket building	*"Model Rockets,"* part 1 (60 min.)	• Inventory parts of kit. • Follow directions to build and paint model rocket.	Complete rocket through stage of gluing fins and launching lug.

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Sample LESSON PLAN for Day Camp and Afterschool Programs — Day 3

Topic	Activity (Time)	Objectives for Members	Key Points for Leaders
Day 3			
Gravity	*"Forces"* Video (15 min.) Discussion (15 min.)		• View rest of video. • Discuss how gravity affects the Space Shuttle on earth and in orbit. See Leader's Handbook pp. 12-13.
Rockets at work	*"Balloon Rockets"* Experiment (20 min.)	Discover principles of rocket engine operation.	Discussion • Balloon are examples of rockets. Why?
Gravity	*"Gravity & Me"* Games • *"Gravity Relays"* • *"Parachute Fun"* (25 min.)	Gain an understanding of basic principles of gravity.	
Food Groups	*"Astronaut Food Relay"* (15 min.)	Identify food groups.	

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Sample LESSON PLAN for Day Camp and Afterschool Programs — Day 4

Topic	Activity (Time)	Objectives for Members	Key Points for Leaders
Day 4 Foods in Space	Discussion (5 min.) *"Food"* video (15 min.) Discussion (10 min.)	• Explore relationship between food and nutrition requirements on earth and in space. • Identify methods of food preparation for space travel. • Experience the sensation of drinking in a weightless state.	Possible discussion questions: • How are food and nutrition the same on earth as in space? • What is different about food and nutrition in space than on earth? • You have just been chosen to be a crew member on the next shuttle flight...what are your first thoughts? • How are foods prepared for space flight? Stop video after 15 min. See Leader's Handbook, pp. 23-25.
Eating and drinking in space	*"Topsey Turvey"* experiment (30 min.)	• Estimate the effects of weightlessness on eating and drinking. • Experience the sensation of drinking in a weightless state. • Identify at least 2 ways food is packaged for space and state the reasons for each.	Discussion • Eating/drinking in space requires new procedures and food packaging. • Swallowing food is controlled by throat muscles, not gravity.
Rocket building	*"Model Rockets,"* part 2 (30 min.)		Complete rocket except for painting.

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Sample LESSON PLAN for Day Camp and Afterschool Programs — Day 5

Topic	Activity (Time)	Objectives for Members	Key Points for Leaders
Day 5			
Food drying	*"Chewy Leathers"* and *"Veggy Chips"* activities, part 1 (60 min.)	• Explain how foods are preserved for dehydration. • Prepare one or more dried fruits or vegetables for space travel. • Rehydrate dried vegetables. • Recognize that vegetables have a high-water content.	• Complete the activities up to the stage where foods can be placed in a dehydrator or in the sun to dry.
Foods in space	*"Foods"* video (15 min.) Discussion (15 min.)		View rest of video.

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Sample LESSON PLAN for Day Camp and Afterschool Programs —Day 6

Topic	Activity (Time)	Objectives for Members	Key Points for Leaders
Day 6			
Rocket building	*"Model Rockets,"* part 3 (90 min. total)		• Rotate members in groups of 2-3 to paint rockets and do the *"Brown Bag Experiment"* while others play games.
High and low-fat foods	*"Brown Bag Experiment"*	Select the low-fat food from each pair of foods.	Discussion with members: • Low-fat foods often have a high water content (eg. fruits, vegetables) • High-fat foods can contain alot of 'hidden' fat. For younger kids, share answers orally instead of using the handout.
Gravity	and *"Gravity & Me"* Activities: • *"Gravity Relays"* • *"Parachute Fun"* • *"Balls, YoYos, Hula Hoops,* and Much More"		

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Sample LESSON PLAN for Day Camp and Afterschool Programs — Day 7

Topic	Activity (Time)	Objectives for Members	Key Points for Leaders
Day 7	Rotate teams through 4 stations (90 min.)		Discussion:
Low-fat food choices	•"Trip to Lowfatum" game		• Lowfat food choices are good for your heart.
Water–We need it in space and on earth	•"Water You Think" game	• Discuss the role of water in the human body. • Recognize that fruits and vegetables have a high-water content. • Explain how fruits and vegetables are preserved for space travel by dehydration and irradiation.	• Discuss the role of water in our bodies. Refer to information sheet attached to activity/game. Review dehydration/rehydration from session 5, Food Drying. • Use game cards for 9 year olds.
Rocketry	"Blast Off," part 1		• Review *Model Rocket Safety Code* with members. Designate "safety area" at launch site. Let members sign up for launch time. (Only one launch at a time.)
Your senses and food	"Sensory Experiments"	• Understand how the four senses of taste, see, feel and taste influence food likes and dislikes. • Make a decision about food preference. • Recognize that individuals have different food likes and dislikes.	

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Sample LESSON PLAN for Day Camp and Afterschool Programs — Day 7

Topic	Activity (Time)	Objectives for Members	Key Points for Leaders
Day 8	*"Search for Space Food"*	• Learn that many products in grocery stores use space technology in preparing, preserving and packaging. • Identify the information on every food label.	Instead of visiting a market as the activity suggests, bring 50 samples of canned, freeze-dried, reconstituted, frozen, baked and dehydrated products. Empty containers are okay. The more the better. Set up a 'supermarket' on site.
	"Chewy Leathers" and *"Veggy Chips,"* part 2 (45 min.)	• Taste dehydrated and rehydrated food products.	• Members share results and how product was prepared. • Members complete *"Chewy Leathers"* handout. • Tasting party.

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Sample LESSON PLAN for Day Camp and Afterschool Programs — Day 9

Topic	Activity (Time)	Objectives for Members	Key Points for Leaders
Day 9	*"Germs, Boogers, Bacteria,"* part 2 (15 min.)		• Members share results and draw pictures. • Discuss differences between the clean and dirty bread samples.
	Rotate teams through 4 stations: • *"Trip to Lowfaturn"* • *"Water You Think"* • *"Gravity and You"* • *"Forces"* video (75 min.)		Select one or more activities/ games

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Sample LESSON PLAN for Day Camp and Afterschool Programs — Day 10

Topic	Activity (Time)	Objectives for Members	Key Points for Leaders
Day 10			
Rocketry	*"Blast Off"* (75 min.)	• Understand and abide by *Safety Code*. • List phases of flight. • Prepare model rocket for launch.	
Closing	Presentation of certificates and buttons (15 min.)		Refer to National 4H Council order form

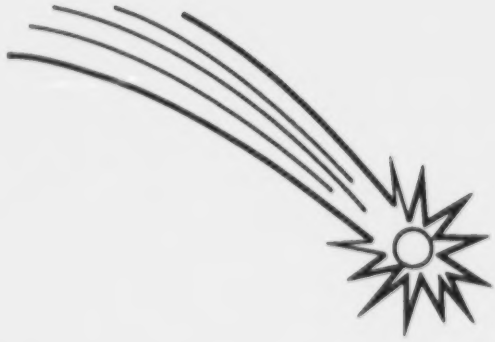
LESSONS
ACTIVITIES

GRAVITY AND ME

Topic — Gravity

Members Should Be Able To

- gain an understanding of the basic principles of a natural force—gravity.
- explore the effects of gravity in their daily lives.
- use experimentation to discover solutions to everyday problems.



You Will Need

- Two different types from each of the three categories: ball, yoyo, hula hoop.
- Space Tag — no supplies needed
- Gravity Relays — spoons and balls or round fruit
- Flying Saucer — tin plate or frisbee
- Parachute Fun — one large parachute and ball(s)
- Lift Off — no supplies needed

Background Information

These activities can be played individually or as part of a team by members of all ages.

The three basic principles of gravity are (1) every particle attracts every other particle; (2) the amount of gravitational pull, depends on the mass or weight of both particles; and (3) the greater the distance between the center of an object or mass, the less the pull of gravity. For additional information, see pages 95-99 of this manual.

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What To Do

A variety of activities are provided for youth to explore the effects of gravity and force in their everyday lives. Select one or more activities based on available equipment, location and participants' interests.

• Balls, Yoyos and Hula Hoops
These activities provide opportunities for participants to explore the effects of gravity. Within each of the following four categories, compare the effects of gravity on these objects when used in their normal playing context:

1. Compare types of balls including ping pong-, golf- , beach-, soccer-, and volleyball.
2. Compare brands of frisbees.
3. Compare different sizes of hula hoops.
4. Compare different sizes of yoyos.

• Space Tag
Similar to the "drop the handkerchief" and "elbow tag" games, the players hook elbows to become a circular-shaped space station. Two other players stand somewhere outside the "space station." When a start signal is given, player #1 chases player #2 until player #2:

a.) lands "on the space station" by hooking elbows with one of the space station players. (The person located opposite player #2 takes his/her place and becomes the "new" player #2.)

b.) or is tagged. (Player #2 now chases player #1.)

• Gravity Relays
Two relay teams of equal number face or stand to the side of the other. The first player on each team holds an object which is passed along to each player as quickly as possible until the last player receives the object and runs to the head of his/her line and repeats the process until all team members have had a chance to be at the front of the line. The team finishing first wins. Different objects are used for each relay or each game and could include various types of balls, spoons, oranges or grapefruits.

• Flying Saucer
Similar to the "Spin the Platter" game, this is a good game to help participants learn the names of their team members. The players sit in a circle format. One player takes a tin plate or frisbee to any location within the circle. Then s/he spins the platter while calling out a person's name. The person called must catch the platter with one hand before the platter stops spinning or s/he becomes 'it.'

• Parachute Fun[1]
It is great fun to observe how a parachute reacts to the effects of gravity and wind. For these activities, you will need one large parachute and several small balls. These activities, for at least 20 participants, should take place outdoors on a slightly windy day.

1. With the participants standing about 2-feet apart from one another, each person holds the outside edge of the parachute so that the parachute becomes a taut circle. Using a "caller" to yell out "up" and "down" in order to maintain an even motion, have the members alternately raise and lower their arms pulling the parachute in an "up" and "down" motion.

   While the parachute is in motion, place one or more balls on the parachute. The goal is to get the ball(s) to travel around the parachute without falling off or touching the ground.

2. Create a "mushroom." While the parachute is "up," instruct members to take one step forward and bring the parachute from over their heads to behind them and then sit on the parachute's inside edge. With the parachute tight, the members can roll to their left or right or in a circular motion to create a moving mushroom!

3. Play a game of tag. Number off the participants so there are two of each number. When the parachute is "up," call out a number. The two members with that number must go under the parachute and try to be the first to exit on the opposite side.

[1] adapted from *New Games Book*.

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4. Another activity is to let the smallest member lie flat on her/his back in the center of the parachute during the "up and down" motion. Does the member "fly?" If yes, let the next to the smallest try it, etc.

5. Let go of the parachute when "up" and see how it flies!

• Lift Off

This experiment illustrates the relationship between engine power and gravitational pull.

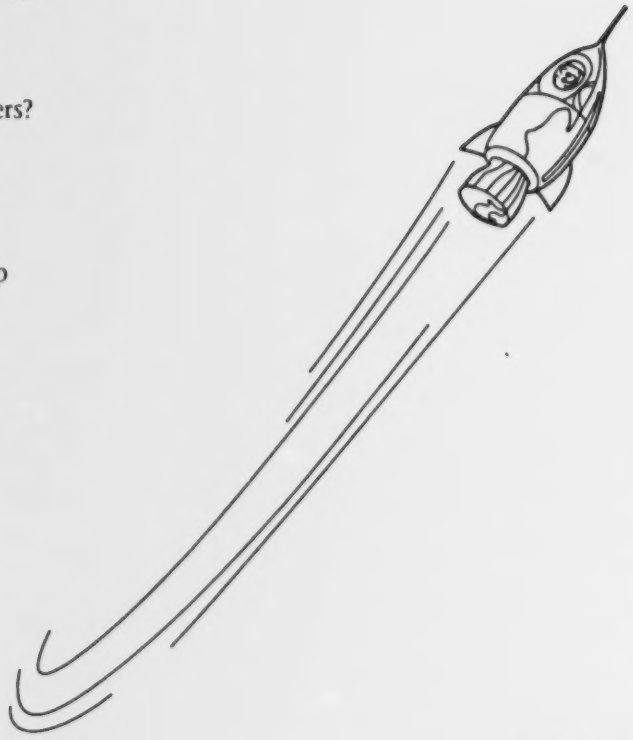
1. With each member standing 2 to 3 feet apart, have members line up single file shoulder to shoulder. With hands on hips, ask members to do a standing broad jump. How far can they jump?

2. Same as step 1 but tell the members to swing their arms to assist them in jumping. How much further did they jump? Their arms are their engine power.

3. Ask members to form teams made up of three members. Within each team, one member is a rocket and the other two are rocket boosters. On the the count of 3, the rocket jumps up and the two rocket boosters lift the rocket by holding each arm between the shoulder and elbow. How high did the rocket go with boosters?

   Which human rocket goes farthest?

   - rocket without boosters (standing/ jump);
   - rocket without boosters (stand/jump with arms);
   - rocket with boosters.



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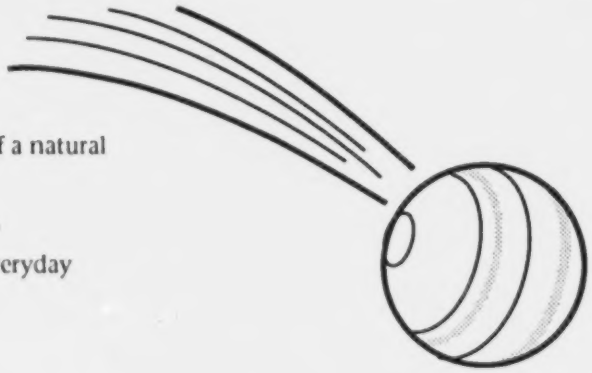
ROCKET BALL



Topic — Gravity

Members Should Be Able To

- gain an understanding of the basic principles of a natural force—gravity.
- explore the effects of gravity in their daily lives.
- use experimentation to discover solutions to everyday problems.

You Will Need

For each team or member

- One piece of string or colored yarn, 36 inches long
- One sheet of paper, any color, minimum size 8½ by 11 inches
- clear scotch tape

Background Information

This experiment will illustrate the relationship between gravity and velocity (speed) upon the orbit of the space shuttle. With the power of its engines, the shuttle is able to break away from the Earth's gravitational pull. Once in orbit, the shuttle can remain in orbit because its incredible speed or velocity of 17,500 MPH is sufficient to overcome the gravitational pull of the Earth. With the balance of the shuttle's speed and the Earth's gravitational pull, the shuttle circles the Earth every 90 minutes. When the shuttle slows down, gravity takes over, pulling the shuttle back toward the Earth's tremendous mass.

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What To Do

1. Instruct each member to wad paper into a ball shape and secure ball with tape. Then attach string/yarn to the ball by wrapping it around the ball and taping it to the ball to keep the string securely attached.
2. Have members experience the circular motion of the "rocket ball" by holding the end of the string/yarn and swinging the ball first slowly in a circular motion then faster and faster. The faster the engine, the stronger the effect of directional control. The gravitational pull to the Earth is not strong enough to bring down the ball until the ball's speed decreases.

❖ ❖ ❖

Discussion

1. What happens as the rocket ball goes faster?
2. What happens when you stop the circular motion or swinging?
3. Is there a difference between swinging the ball vertically and horizontally?
4. Shorten the string of the rocket ball. Does the ball need to move faster or slower to stay in orbit?
5. Lengthen the string and repeat as in part 4. How does this experiment relate to the shuttle?

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GERMS, BOOGERS AND BACTERIA

Topic — Bacteria on Earth and in Space

Members Should Be Able To

- Describe why it is important to wash hands before touching/preparing food.
- Identify the role of bacteria in food spoilage.
- Observe the effects of water, temperature etc. on the rate of food spoilage.
- Make scientific observations and record those observations.

You Will Need

- Handout #1: Observations Record (3 copies for weeks 1,2 and 3)
- 1 or 2 pieces of fresh white bread...either plain white bread or sweet french bread.
- 2 Ziploc plastic bags or 2 clear glass jars with lids. (Any size Ziploc bag will work: sandwich size bags are the least expensive).
- 2 short pieces of masking tape to label the two containers.
- Soap, water and towels for each member to wash and dry hands.
- Pencil and writing paper.
- Medicine dropper (optional).

Background Information

Although scientists have not yet found life (including germs, boogers and bacteria) in outer space, it is possible that germs might find their way into space vehicles leaving Earth. On Earth, germs and bacteria seem to be *everywhere* !! In fact, one of the main causes for food spoilage is bacteria. This activity shows that touching food with dirty hands contaminates food with bacteria.

For best bacterial growth, the bags or jars should be kept in a shaded area at a temperature between 50° - 100° F. The jars should be kept where members can observe and record their observations each day for three weeks.

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What To Do

1. A week ahead, ask members to bring 2 glass jars with lids or Ziploc plastic bags.
2. Photocopy 3 copies of Handout #1 for each member.
3. Read about the activity. Purchase fresh bread and other supplies.

Directions (45-60 minutes):

1. Ask one member to demonstrate for the group using these directions.
   - Using a piece of bread (about 1/2 slice), wipe your dirty hands on the bread.
   - Put about 10 or 15 drops of water on the bread. Use your finger or a medicine dropper.
   - Put the moist bread into a container.
   - Now wash your hands with soap and hot water. Dry your hands.
   - Wipe your clean hands on another piece of bread (about 1/2 slice). Moisten this bread with the same number of water droplets as before and put in the other container.
   - Seal both containers.
   - Put a piece of masking tape on each container. Mark each with your name, date and identify as "clean" or "dirty" hands.
2. Give each member an opportunity to prepare his/her own experiment.
3. Discuss Handout #1: Observations Record for Weeks 1, 2 and 3. Ask members to record what they see happening to the bread each day for 3 weeks. Also encourage them to draw what they see.

or

Discussion Day 1 and 2

Discuss with members what it means to make a prediction. Ask members to predict what will happen to the bread over the next 3 weeks.

- What do you think will change?
- What do you think will cause the changes?
- What do you think will stay the same?

You may prefer to have members write their predictions for the purpose of comparing them with actual results in 3 weeks.

Discussion Day 21

After members have recorded their observations for 3 weeks, ask members to compare their results with those of a friend(s).

- What is different?
- What is the same?
- What do you think happened?
- How can you be sure?
- What does this experiment have to do with preparation for space travel?
- What did you learn that would help you keep foods safe to eat?

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Variations

For older members, make this activity more interesting and complicated by changing the temperature, moisture content, contaminants and/or light source for the bread. Ask members for their ideas. Many possibilities and combinations exists. Here are a few for each set of clear and dirty bread samples:

TEMPERATURE:

1. warm site
2. refrigerator
3. freezer

MOISTURE:

1. 0 drops of water
2. 10 drops of water
3. 20 drops of water
4. 30 drops of water

LIQUID:

1. water
2. apple juice, diluted 4 parts water to 1 part juice
3. apple juice, diluted 2 parts water to 1 part juice
4. apple juice, diluted 1 parts water to 1 part juice
5. apple juice, undiluted

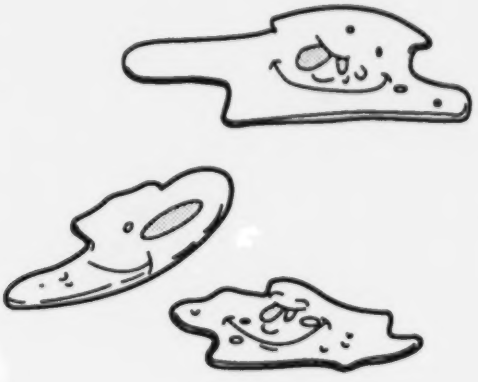
CONTAMINANTS:

1. Rub shoes on bread
2. rub bread on a plant and/or floor
3. lick bread
4. cough on bread

LIGHT SOURCES:

1. sunlight
2. florescent light
3. incandescent light
4. darkness

Older members can plan their own observation record forms.



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HANDOUT #1:
Blue Sky Below My Feet
Germs, Boogers and Bacteria
Name: _____

For the members

Observation Record

Dates: From _____ To _____ Week # ☐

DIRECTIONS:
Record what you see happening to the bread each day for three weeks. You may want to draw what you see in the containers. Handout #1 is a sample of a chart for recording your observations.

DAY ☐ Clean-hand Bread	Dirty-hand Bread
DAY ☐ Clean-hand Bread	Dirty-hand Bread
DAY ☐ Clean-hand Bread	Dirty-hand Bread

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Page 2 of the Observation Record

DAY ☐ Clean-hand Bread	Dirty-hand Bread
DAY ☐ Clean-hand Bread	Dirty-hand Bread
DAY ☐ Clean-hand Bread	Dirty-hand Bread

Using the back side of this page, write your general observations about what you've seen in the jars.

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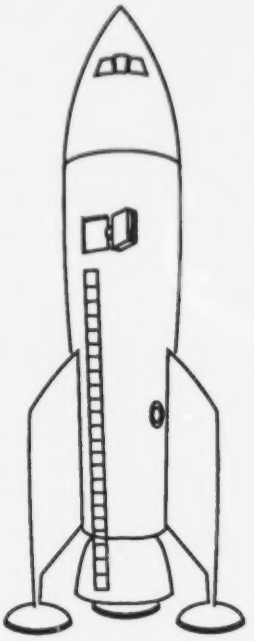
MODEL ROCKETS



Topic — Rocket Building

Members Should Be Able To

- Follow sequential directions for building a model rocket.
- Gain a sense of accomplishment by building the rocket.

You Will Need

For each member

- model rocket kit
- sandpaper (2 x 4 inch strip)
- one tall 12 oz. or larger paper cup

For members to share

- white glue
- plastic model cement
- ruler
- pencils
- scissors
- masking tape
- marking pens, assorted colors
- spray paint
- dowels or balloon sticks
- covered table space
- a door jam (helps to correctly measure fin and lug placement)

Background Information

This activity is appropriate for 9 year olds and up (or 8 year olds with an older partner). If the participant's reading ability is inadequate, adults and teens are required to provide step-by-step instruction. The excitement level will be high because everyone seems to enjoy building a model rocket. Members will have a sense of accomplishment when rockets are finished.

Each model rocket kit includes detailed instructions. Select a kit that is recommended for Skill Level 1: Beginners. You may purchase the "Blue Sky Club" model rocket from National 4-H Supply, or purchase models directly from ESTES, or from local hobby stores. Popular beginning rockets are ALPHA (model #1225) and NINJA (model #0882). The ALPHA has a parachute; the other two have streamers. Rocket engines are purchased separately.

Request the free Estes Catalog & Teachers Guide at: Estes Industries Education Department, Dept. 194, Penrose, Colorado 81240 L.

Group discounts are available from Estes but you may want to check at a local hobby store for group discounts on smaller orders.

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What To Do

Review the directions that accompany the rockets. Here are some additional comments.

1. Have each member mark a paper cup with his name.
2. Direct each member to open one model rocket kit carefully and place all parts in the paper cup.
3. Have each member inventory the rocket parts in his/her cup by checking them off the inventory list included in the kit. This activity helps members become familiar with rocketry terminology and double-checks that all parts are present. *(If everyone is building the same model, you may want to purchase one or more extra kits for spare parts.)*
4. At the first session, the model rocket engine mount, fins and launch lug should be glued in place. Have members place the rocket nose first, into paper cups to dry. Let them dry at least overnight before reinforcing the body and fin/lug joints, and completing the other remaining steps. This stopping point also provides you with time to double check that the fins are equally distributed around the rocket body. Uneven fins mean unsafe flight.
5. Mark each model inside the nose cone end with a name or initials.
6. Paint the model rocket with the nose cone in place. Be sure not to overpaint the nose cone area because it must be easily removed. Use the dowels/balloon sticks to hold the rockets at a distance so they can be evenly sprayed with paint. Dark paints work well. Dark colored rockets can be seen against the sky. White and yellow colored rockets are difficult to see during flight.
7. Members may want to apply the decals or decorate their model rockets with felt pens.

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BALLOON ROCKETS[1]

Topic — Rockets at work

Members Should Be Able To

- discover the principles of rocket engine operation.
- develop new problem-solving skills.

You Will Need

For each member

- one balloon

For each team

- one balloon
- scotch tape, 8 inch piece
- string, 5 feet or longer
- one straw, non-flexible
- straight pin

Background Information

Teams of 3 to 4 participants will create an environment of team problem solving and cooperation. Your challenge as a project leader or teacher is to help members learn how rocket engines work. Let members experiment for themselves so they can develop their own decision making skills and self-confidence.

Everyone probably has flown a rocket. A balloon is a rocket! It is not well guided, but it flies when released according to the same action-reaction principle as a full-sized rocket with engine.

As the air rushes out the nozzle, the air inside pushes equally on the remaining interior surfaces of the balloon. The forces on the inside walls of the balloon are equal. The only unbalanced force is on the balloon's inside surface opposite the nozzle. This unbalanced force propels the balloon in the direction opposite the nozzle.

Of course, the balloon is not perfectly symmetrical and easily distorts. In addition, the nozzle is flexible so the flight of this "rocket" is somewhat erratic.

[1] This activity was adapted from the "Model Rocketry Manual," Minnesota Extension Service, Pages 24-25, 4-H-BU-0259, Revised 1987.

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What To Do

1. Ask members to inflate the balloons without tying a knot. Ask them to predict which direction the balloon will fly when let go. Who or what is in control of the direction of flight? As space scientist, it is your job to solve this problem. How can one make a balloon fly straight?

2. Divide members into teams of three. Give each team the supplies. The task is to make the balloon fly in a straight line using only these supplies. Let teams experiment until they find the answer.

   Sample Answer:

   Step 1: Thread the string through the straw.

   Step 2: Two team members hold the opposite ends of the string in a straight line at waist level.

   Step 3: The third team member inflates the balloon and attaches the balloon's side to the straw with the tape.

   Step 4: Let go of the balloon. It should travel the length of the string with the straw and string as its guide.

3. After discovering a solution, participants can further experiment by having competitive events, and/or testing their model against gravity or each other's force or hot air.

4. Participants may want to predict what will happen when an inflated-tied balloon is stuck with a straight pin. Will it violently explode?

   (Answer: You can gently stick a straight pin into a balloon that is not fully inflated at the tip opposite the hole, where the rubber is thickest. The pin penetrates the surface if inserted gently. Leave the pin in the balloon and air will not escape.)

5. Discuss the following questions with participants:

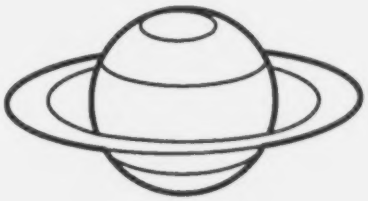
   a. Before you release the nozzle of the balloon and allow air to escape, describe what the air does inside the balloon?

      (Answer: It pushes equally on all interior surfaces. If it did not push equally in every direction, it would be moving in the direction it pushed hardest.)

   b. What happens when you allow air to escape from the nozzle?

      (Answer: The part of the balloon opposite the nozzle experiences an unbalanced force. The air inside pushes on the part of the balloon opposite the nozzle. The balloon moves in the direction opposite the nozzle.)

   c. Have participants compare theballoon with a model rocket and its engine. How is launching a model rocket similar to the balloon rocket experiment just completed?



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ASTRONAUT FOOD RELAY

Topic — Food groups

Members Should Be Able To

- increase awareness of the basic food groups or food types.

You Will Need

- 10 food containers, such as milk carton, egg carton, orange juice can, cereal box, etc.
- paper and pencils for score keeping

Background Information

Food guides are a tool to help you select foods wisely. They are merely a tool! They come in many shapes, sizes, format and content.

Food guides divide foods into groups according to the nutritional contributions and provide a suggested number of servings. American food guides now feature low-fat, low-sugar and low-sodium food choices in each group. High-fat, high-sugar or high-sodium foods are foods to use with "caution." These foods are part of the "other" group.

Whatever food guide you use, try to be consistent in the food groups or types. For example, *"Food Choices For Variety: A Food Planner,"* uses six food types/groups and a caution group.

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What To Do

1. Divide 8 members into two teams of 4 each. Form two lines 30 feet apart. Line up the 10 foods midway between the 2 teams. Ask members the name of each food and food group (see Figure below).
2. The game is played like a relay race with one teammate per team running at one time. Give teams a chance to plan a strategy.
3. When the leader gives the signal to start, the relay race begins. The goal is for each team to end up with a food from each of the food groups or types. The foods from the caution or 'extra' group do not count.

Discussion

1. Discuss with members the food groups/types and the 'extra' foods. Share examples of foods in each group. For many children, this will be a review.
2. Do astronauts need foods from the first food groups/types?

   (Answer: Yes, astronauts need foods from all the food groups/types, except the 'extra' or caution group. Astronaut nutrient needs are the same as everyone's.)
3. Do astronauts eat healthy foods and exercise regularly?

   (Answer: Yes, it is essential and part of their training program.)

Variations:

To make the game more challenging

- change the 10 foods after each race
- use more than ten foods

Astronaut Food Relay Figure:

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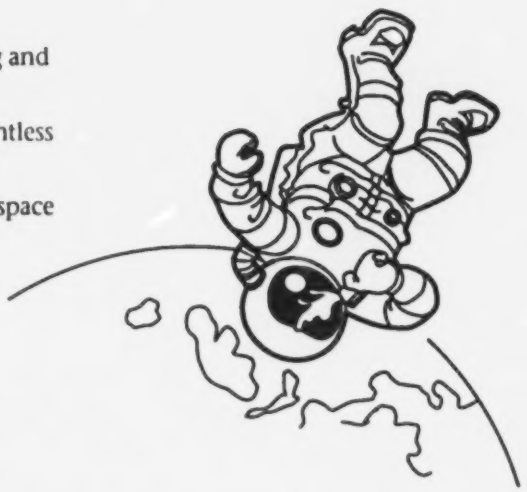
TOPSY TURVEY

Topic — Eating and drinking in space

Members Should Be Able To

- Estimate the effects of weightlessness on eating and drinking.
- Experience the sensation of drinking in a weightless state.
- Identify at least two ways food is packaged for space and state the reasons for each.



You Will Need

- flexible drinking straws, one per member
- roll of paper towels (for clean up)
- water to drink (juice in 8 oz. cartons works well but is expensive).
- milk cartons, ½-pint containers (rinsed), one per team or member (recycled plastic squeeze bottles–catsup, detergent, honey–work well)

Background Information

Weightlessness does not affect a crew member's ability to swallow. Swallowing is controlled by throat muscles.

Eating solid food in space will not be difficult for crew members who remember to close their mouths. Otherwise, bits of food will float out. Crew members drink by squeezing liquids into their mouths from paper or plastic containers.

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What To Do (60 minutes)

1. A day ahead, ask members to wear pants for this activity.
2. Begin this activity by asking members how space travelers to another planet will eat solid food and drink liquids. Generate more discussion by asking:
   - What will happen to you in space if you chew food with your mouth open?

     (Answer: The food will not stay in your mouth.)
   - What will happen if you drink water from a glass as you do on earth?

     (Answer: Without gravity to hold the liquid in the glass, the water will float out of the glass and move around the cabin. Drinking the traditional way is impossible in space.)
3. The rest of the activity will be done in teams of two or three youngsters.

Directions

1. Ask one team to demonstrate swallowing in an upside down position. One team member leans forward over a table or desk so his or her upper body is free to hang upside down. The teammate assists. Ask the upside down member to swallow 5 times and share how it feels. Ask members if they think someone can drink upside down.
2. Provide each team with one clean milk carton filled with water and some paper towels.
3. Teams simulate a weightless state by having one member hang upside down while the other assists. Drinking upside down can be messy, so have the paper towels ready.

   Note: It is important to have members experience this stage, so they can try to think of a neater way to drink upside down and in space.
4. Ask if members can drink upside down without spilling. How can the situation be improved? If someone suggests using a straw, try it. A space traveller will be able to swallow liquid from a squeeze bottle just as an upside down youngster can swallow liquid with a straw.
5. Allow time for teammates to switch positions. Have extra milk cartons ready.

Discussion

Following clean up, gather teams into one group. Some questions might be:

- How do you think gravity affects your ability to swallow on earth?

  (Answer: Gravity does not affect your ability to swallow. Swallowing is controlled by muscles in your throat.)
- How can you chew and swallow food in space?

  (Answer: Keep your mouth closed. Pass the food to the back of your throat with your tongue, then use your throat muscles to swallow.)

Variations:

- Member stands on his or her head and tries to drink while his or her teammate assists. (Try this against a wall.)
- On a school playground or at the park, member hangs by the knees on the bars while partner assists.
- Member leans backward over a desk or table so the upper body is free to hang upside down. *Caution: some padding may be necessary for comfort and safety.*

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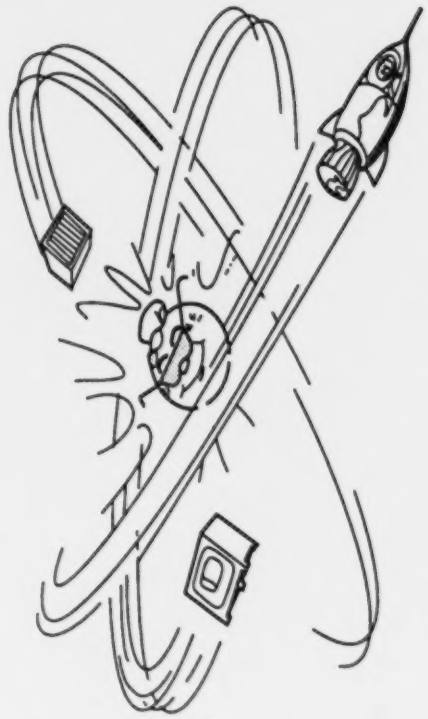
CHEWY LEATHERS

Topic — Food drying (dehydration)

Members Should Be Able To

- Prepare two or more nutritious snacks.
- Explain how foods are preserved by dehydration.
- Recognize that fruits have a high water content.



You Will Need

For each member or team

- fresh, canned, or frozen fruit and/or fruit flavored yogurt
- lemon or orange juice, if light-colored fresh or canned fruits
- blender or food processor
- cookie sheets or trays, Teflon coated or sprayed with oil or lined with a heavy plastic wrap
- measuring cups, spatula, paring knives, and bowls
- oven or sunny location or dehydrator
- cheesecloth, if sun drying
- handout, *"Chewy Leathers,"* and pencils
- commercial fruit leather (to compare to the homemade product)

Background Information

These activities are appropriate for all ages. Members may do them individually or as part of a team. Fruit leathers and dried yogurt are nutritious snacks children enjoy. Making fruit leathers provide the opportunity for members to explore drying as a method of food preservation.

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How To Make Fruit Leathers

For specific directions on making fruit leathers and dried yogurt, see the handout. For more information, refer to "Drying Foods at Home" Leaflet 2785, Division of Agricultural and Natural Resources, University of California. This leaflet is available from your local county UC Cooperative Extension office. Also refer to the Appendix, for an article by Daniel F. Farkas, "What are the Benefits of Food Dehydration?"

Leathers are dried, rolled sheets of plain or sweetened pureed fruits. The produce is processed in a blender, spread in a thin layer and dried to a chewy perfection. Any fresh, canned, or frozen produce is suitable.

The following fruits make excellent to good leathers: Apples, peaches, apricots, pears, berries, pineapples, cherries, plums, nectarines, and strawberries.

These fruits are not recommended: Citrus, avocados, currants, melons, olives, persimmons, pomegranates, and quince.

All other fruits may be used in combination with the fruits identified as excellent to good.

Unsweetened applesauce may be used for a short-cut method. Begin with step 2.

You can also use fruit-flavored yogurt to make a chewy leather. Spread evenly the yogurt directly from the container but only ⅛-inch thick on trays or cookie sheets as directed in step 2 for making fruit leather. The drying times for yogurt are similar as for fruits.

STEP 1: Wash, remove any bad spots, stem and pit, and peel fresh fruit, if desired. Drain canned fruits, and thoroughly thaw frozen ones. Cut the fruit into pieces, place in blender, and puree until smooth. For a fresher flavor with canned fruit, add one tablespoon fresh lemon, lime, or orange juice per quart of puree.

STEP 2: Select one or more methods of drying.

Sun drying: Pour the puree on a cookie sheet lightly coated with vegetable oil or with a nonstick vegetable spray or lined with a heavy plastic wrap. DO NOT use a plastic bag , aluminum foil, or wax paper. The poured puree should be about ¼-inch thick. Protect the fruit from insects by placing cheesecloth over—but not touching—the fruit. Place the pans in full sun. Bring the pans indoors at night. It will take about 2 days to dry if the daytime temperature is around 100°F.

Oven drying: Follow the same directions as for sun drying, EXCEPT set the oven temperature at the lowest temperature and let fruit dry for several hours. If there is a ventilating fan above the oven unit, use it to speed up the drying. Open the oven door occasionally to allow any steam to escape. Rotate the pans halfway through the drying cycle—front-to-back to speed the drying process. Drying time will vary depending upon the amount of moisture in the puree and the air humidity.

Dehydrator: Follow the manufacturer's directions. The thermostat should be set at 135°F. Average drying time is 4 to 6 hours.

STEP 3: When the puree is leathery and pliable with no sticky spots, your leather is done. Peel up an inch or so of the sheet along the edge to check. If the leather meets the test, peel it off the tray or wrap while it is still warm. It should come off in one sheet with no puree sticking.

STEP 4: To store your fruit leathers, roll the leather and wrap thoroughly in plastic wrap. You can also cut the roll up into bite-size pieces and wrap individually. Store the wrapped leathers in sealable plastic bags or airtight containers. This preserves the freshness and will keep out the moisture. Put the bags and containers in a cool, dry, dark place for long-term storage.

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What To Do

1. Select the fruit(s) to be dried as leather. Gather all equipment and supplies. Distribute copies of the handout.
2. Discuss with members the methods of home dehydration (sun, oven & dehydrator) and the benefits of drying foods for eating on earth and in space.
3. Make the fruit and/or yogurt leathers.
4. Evaluate the homemade leathers by using the handout. Discuss results.
5. Purchase commercial fruit leathers of the same fruits as the homemade to compare quality, and cost using the handout.

Discussion

You and your crew are gathering food for your mission into space. All of you know fruits and vegetables are important for balanced meals, but you will have limited storage and no refrigeration aboard your spaceship. Dried foods are lightweight, low in volume, and require no refrigeration. They are excellent food sources for your flight into space.

To prepare for your trip, let's learn how fruits can be dried for nutritious snacks. Drying and dehydration refer to the removal of water. Dried foods have been used for survivial from early nomadic times to modern times, including space travel. Fruits are dried commerically and can be dried at home. The home methods of drying foods are sun drying, oven drying, and using a dehydrator.

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CHEWY LEATHERS

You can be the judge as to the quality of your homemade fruit leathers. What are your results?

Step 1: Answer these questions for each fruit leather you made. If any of your answers are NO, discuss why and how you might improve your product.

Yes No

___ ___ Is the leather dry enough to hold together when picked up, but not so moist that you can sqeeze liquid out of it?

___ ___ Is the leather free from large seeds, most peelings or large pieces of fruit?

___ ___ Is the color attractive and only slightly darker than the fresh fruit from which it was made?

___ ___ Is the flavor pleasing—not too bitter, too tart, or too sweet?

___ ___ Are the strips of fruit leather evenly cut and properly rolled?

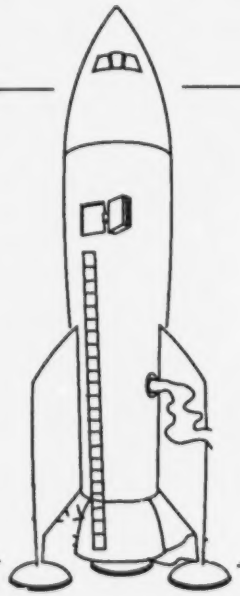
___ ___ Is there any mold present after storing it for awhile?

Step 2: Compare store bought fruit leathers made of the same fruits as your homemade fruit leathers.

a. List the ingredients.

HOMEMADE

STORE-BOUGHT



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b. Are the quality and flavor of the homemade and store-bought items similar? Yes or No? If no, describe the difference.

c. Which product is more nutritious or has more fruit and less sugar?

d. How does the price compare? Which is more expensive—store bought or homemade?

e. Which fruit leathers would you like to take on your trip into space?

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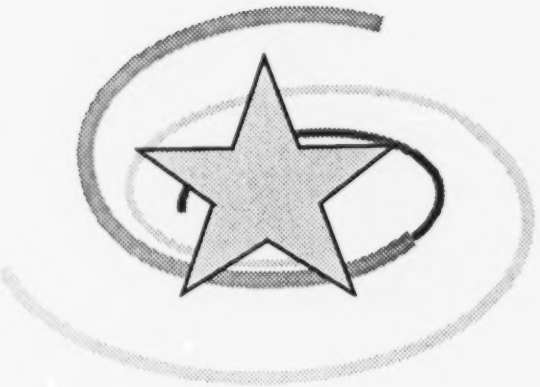
VEGGY CHIPS

Topic — Food dehydration and rehydration



Members Should Be Able To

- Prepare one or more dried vegetables for space travel.
- Explain how foods are preserved by dehydration.
- Rehydrate dried vegetables.
- Recognize that vegetables have a high-water content.

You Will Need

For each member or team

- fresh vegetables, such cucumber, zucchini, tomato, squash, parsnip
- cookie sheets or trays, Teflon coated or sprayed with oil or lined with a heavy plastic wrap
- sharp paring knives and bowls
- oven, sunny location, or dehydrator
- cheesecloth, if sun drying
- handout #1, *"Veggy Chips"*

Background Information

These activities are appropriate for all ages. Members may do them individually or as a team. Vegetable chips, which are nutritious enjoyable snacks for children, make excellent additions for soups and sauces. Making vegetable chips provide the opportunity for members to explore drying as a method of food preservation.

For specific directions on making vegetable chips, see handout #1. For more information, refer to *Drying Foods at Home,* Leaflet 2785, Division of Agricultural and Natural Resources, University of California. This leaflet is available from your local county UC Cooperative Extension office. Also refer to the Appendix for the article by Daniel F. Farkas, "What are the Benefits of Food Dehydration?"

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What To Do

1. Select the vegetable(s) to be dried as chips. Gather all equipment and supplies. Make copies of handout #1 for each member or team.
2. Discuss with members home dehydration methods (sun, oven and dehydrator) and the benefits of drying foods for eating on Earth and in space.
3. Make the vegetable chips as directed.
4. Learn about rehydration using handout #1.

How To Make *Veggy Chips*

VEGGY CHIPS are thinly sliced dehydrated vegetables. They make a great nutritious low-calorie snack. The vegetables most suitable for chips are zucchini, tomato, squash, parsnip, turnip, cucumber, beets and carrots. You can serve them with your favorite dip. In addition, sliced onions, peppers and mushrooms can be dried to add to soups and sauces.

STEP 1: Select the vegetable(s) to be dried.

STEP 2: Wash fresh vegetables and peel, if desired. Slice the vegetable into ⅛ inch thick slices by hand or with a food processor. For using the dried product in soups and sauces, you may dice or shred the vegetables. Be sure to cut pieces uniformly for more even drying.

STEP 3: Vegetables with a long cooking time, such as carrots, parsnips, turnips, squash, etc. should be blanched to stop the enzyme action that causes flavor loss. Vegetables with a short cooking time, such as zuchinni, beets, cucumbers, peppers, onions, mushrooms, or tomatoes, don't require blanching.

Blanching reduces the number of microorganisms that cause spoilage. It also preserves color, stops the ripening process, and generally make the produce dry faster.

The following chart shows selected vegetables and blanching times:

Vegetable	Minutes	
	in boiling water	in steam
Carrots	—	3-5
Turnips	3-5	5-8
Parsnips	2-3	3-5

STEP 4: Select one or more methods of drying.

Vegetables are much lower in sugar and acid than fruits, and so must be dried under more controlled conditions to prevent spoilage during the drying process. Drying time and temperature are crucial to the tenderness of dried vegetables. The longer the drying time, the less tender they will be.

Oven Drying: The tray must be at least 1½ inches narrower than the inside of the oven to allow for air circulation. Or you can cover the oven racks with cheesecloth and lay a single layer of sliced vegetables on the cheesecloth. Do not dry more than four pounds of vegetables at one time. Place an oven thermometer on the top tray towards the back and set the oven on the lowest bake setting. During the drying time, the internal temperature shall not exceed 140 degrees. Vegetable temperatures above 140 degrees cause a loss of nutrients and reduce tenderness. Leave the oven door open for improved circulation and turn on the ventilating fan, if available. Drying time is four to six hours.

Sun Drying: Drying in the sun is unpredictable unless temperatures are over 100 degrees and the relative humidity is low. If the temperature is too low, humidity too high or both, spoilage will occur before drying is achieved. Place the prepared

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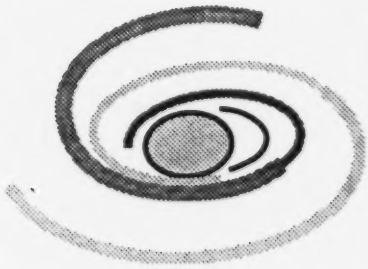
slices on clean trays as above and cover with cheesecloth to guard against insects. The cheesecloth should not touch the product on top. Lay the trays in full sun. Turn the slices once a day to speed drying. Move the trays inside at night. It may take up to four days to dry the vegetables chips.

Dehydrator: Follow the manufacturer's directions. The thermostat should be set at 140 degrees. The average drying time is 7 to 9 hours.

STEP 5: The vegetables are dried when they are tough to brittle.

STEP 6: Package in air-tight containers to keep out the moisture and retain freshness. Even when properly packaged, vegetables will not keep in good condition as fruits. Most dried vegetables should be used within six months. The longer they are stored, the tougher they become.



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HANDOUT #1:
VEGGY CHIPS

For the member

You and your crew are gathering food for your mission into space. All of you know vegetables are important for balanced meals but you will have limited storage and no refrigeration aboard your spaceship. Dried foods are lightweight, low in volume, and require no refrigeration; therefore, they are excellent food sources for your flight into space.

To prepare for your trip, let's learn how vegetables can be dried for later use. Drying and dehydration refer to the removal of water. Dried foods have been used for survival from early to modern times. Vegetables are dried commercially and can be dried at home.

The home methods of drying foods are sun drying, oven drying, and using a dehydrator. To explore food dehydration, select one or more vegetables to make vegetable chips.

If we do not want to eat the vegetable chips as a snack, what are some other uses? Dried vegetables may be used in soups, stews, breads, or casseroles, or combine them with fresh or frozen vegetables. You may also serve them in a sauce. For best results, dried vegetables should be rehydrated before cooking.

To rehydrate or add back the water to dried vegetables, place the product in a container and pour an equal amount of liquid over the dried vegetable. For example, rehydrate one cup of carrots with one cup of water. Cold liquid is fine but boiling or warm liquid will shorten the rehydration time.

Soak vegetables from 10 minutes to 2 hours depending upon the thickness of the pieces and whether cool or boiling liquid is used. Soaking any longer than 2 hours could cause spoilage.

Vegetables are considered rehydrated when they plump up to their fresh size. Do not soak dried leafy vegetables such as cabbage, chard, spinach and lettuce. They will rehydrate well during the cooking process.

After rehydration, you can use the vegetables in your favorite recipes or serve plain or with a sauce.

❖ ❖ ❖

Activity 1

Rehydrate your homemade dried vegetables and add to an instant soup for a snack or light meal.

Activity 2

Try drying a variety of vegetables to use in a soup. Here's a recipe using beef or chicken bouillon, instant rice, and dried vegetables.

4H-EFNEP
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CUP-A-SOUP

Ingredients for 1 Serving

- 1 teaspoon dried vegetables, chopped
- 1 bouillion cube
- 1 teaspoon instant rice
- boiling water
- styrofoam cup, 6-8 oz. size
- plastic spoon

Directions:

1. Place 1 teaspoon vegetables in styrofoam cup. Fill with boiling water. Wait 20 to 30 minutes while vegetables rehydrate.
2. Drain water from vegetables.
3. Add bouillon cube and rice to soaked vegetables.
4. Fill with boiling water. Stir.
5. Eat.

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BROWN BAG EXPERIMENT

Topic — High- and low-fat foods

Members Should Be Able To

- Select the low-fat food from each pair of foods.

You Will Need

- brown paper bags, any size, one per member or team
- food samples, in baby food jars, original containers, or Ziploc bags
- marking pens, thin tip, one per member or team
- handout, "Brown Bag Experiment" and pencils, one per member or team

Background Information

Most of us eat too much fat. Our bodies need some fat, but not the amount we may be accustomed to eating. We know there is a relationship between obesity and eating more calories than we need. However, the relationship between consuming too much fat, saturated fat, and cholesterol, and suffering coronary heart disease is not fully understood.

Now is the time for teens to develop eating habits that will stay with them through adulthood. Most of them don't have heart or serious weight problems now. But what about later? A good prescription for a healthy heart and a lean, fit body is a low-fat diet and daily exercise begun in the teen years.

What foods are low in fat?

This chart shows foods that are high in fat and low in fat. To reduce fat intake, substitute low-fat foods for high-fat foods. Sound easy? It's not!

HIGH-FAT FOODS			
salami	butter	potato chips	ice cream
cream	margarine	corn chips	fried foods
salad dressing	oils	rich desserts	bacon

LOW-FAT FOODS	
grains and cereals	fruits
nonfat and low-lat milk	vegetables
lean meat, fish, and poultry	beans

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What To Do

1. The day before the activity, collect high- and low-fat food samples in baby food jars or Ziploc bags. Label each jar or bag with a food name. Identify each pair of foods with a number. Each pair will include one high- and one low-fat food. Possible pairs include:

   (1) peanut butter and apple

   (2) butter and celery

   (3) whole milk and skim milk

   (4) peanut butter and orange juice

   (5) Crisco and orange slice

   (6) margarine and water

   (7) ice cream and carrot

   (8) butter and potato

   (9) oil and vinegar

   (10) potato chip and raw potato

   Any pair of foods will be fine. The clearest examples for youngsters would include a high-fat food like oil, Crisco, or margarine and a low- fat food like water, any fruit, or vegetable.

2. Begin the activity by explaining to members that fat is often hidden away in foods where they can't see it. Visible fat is easy to identify (show a pork chop). Invisible fat is hard to identify (show peanuts and milk).

3. Hand out a pair of food samples and a brown paper bag to each group of 2 to 3 members. (This activity may also be set up as a learning center in the corner of a classroom. Members can rotate in teams of 2 or 3.) Explain the instructions on the handout to members.

Record findings on the handout. Wait 10 to 15 minutes and observe again.

Discussion After The Activity

Following clean up, some discussion questions might include:

1. Which foods could you dehydrate for a trip to Mars? What clues do you have?

   (Clue: *Foods with a lot of water in them are best for dehydration.*)

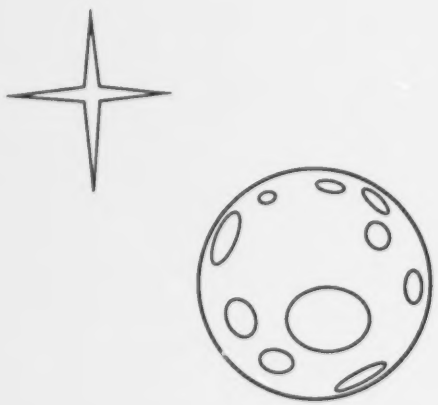
2. Which foods are better for your heart? Which clues do you have?

   (Clue: *Foods containing a lot of fat are not heart healthy foods.*)

3. If you want to be fit as an astronaut, which foods do you want to eat frequently?

   (Clue: *Foods that are low in fat such as fruits and vegetables.)*

4. Which foods do you like best? Least?



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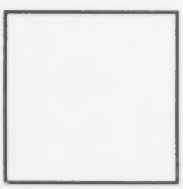
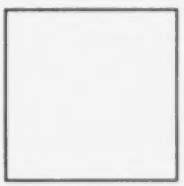
Brown Bag Experiment

Fat is often hidden away in foods where you can't see it.

You can find out if a food contains fat by rubbing it on a piece of brown paper. If the food contains fat, a translucent spot will appear where you rub. Water in food will also make a shiny translucent spot but a water spot disappears when the water dries. A fat spot will not disappear.





On a brown paper bag, outline 2 boxes, 1 inch by 1 inch, for each pair of foods. Mark each box with the name of one food. Here is an example.

Record the food pairs and your findings on this sheet for time zero and 10 minutes later.

FOOD PAIRS	OBSERVATIONS	
	Time zero	10 minutes later
1		
2		
3		
4		
5		
6		
7		

Key Word ***Translucent:***
clear, transparent. For this experiment, a translucent spot is a shiny area on the brown bag that lets light through.

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TRIP TO LOWFATURN

Topic — Low-fat food choices

Members Should Be Able To

- Select two or more snacks low in fat.
- Identify foods with low-, moderate-, or high-fat content.
- Understand the importance of eating a low-fat diet for a healthier life.

You Will Need

For each member or team:

- Handout 1 "High or Low?"
- Handout 2 "Trip to Lowfaturn"
- Handout 3 "Gameboard"
- Scotch tape and colored pens, pencils or crayons
- Dice and markers (such as buttons, beans, etc.)

Background Information

This activity is appropriate for all ages. Members may play the game individually or in teams. The goal is to travel to Lowfaturn by selecting only foods low in fat. The individual or team first to to reach Lowfaturn wins.

Most nutrition authorities recommend that the U.S. population reduce daily consumption of fat. Eating extra saturated fat, high levels of cholesterol, and excess calories will increase blood cholesterol in many people. If you have a high blood cholesterol level, you have a greater chance of having a heart attack. It is recommended you try to avoid too much fat, saturated fat, and cholesterol in your diet.

For more information, refer to the reference *"Nutrition and Youth Health: Dietary Guideline for Americans - Avoid Too Much Fat, Saturated Fat, and Cholesterol,"* Home & Garden Bulletin Number 232-3, USDA. Ask your Cooperative Extension advisor for a copy.

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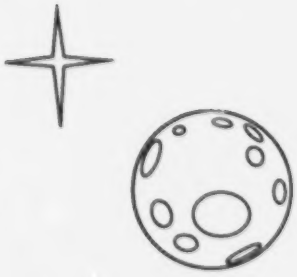
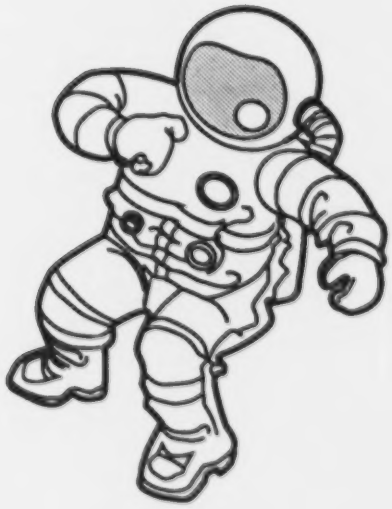
What To Do (30-60 minutes)

1. Discuss with members the importance of eating a diet low in fat.
2. Discuss which foods are low, moderate, and high in fat by sharing handout 1, *"High or Low."*
3. Distribute to members handout 2, *"Trip to Lowfatum;"* and handout 3, *"Gameboard."*
4. Handout 3, *"Gameboard"* sheets need to be taped together. Tape the right margin of page 1 to the left margin of page 2 to make a gameboard 11 by 17 inches. Members can color the gameboard, if desired.
5. Have members play the game, using handout 1 as a reference and handout 2 for the rules of the game.





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Trip to Lowfaturn
HANDOUT 1

For leader and member

FOOD ITEM	LOW-FAT	MODERATE-FAT	HIGH-FAT
Fruits & Vegtables	apple, orange, peach, banana, grapes, melon, and all other fruit carrots, beets, cucumber, celery, broccoli, zucchini, cauliflower, and all other vegetables pickles dried fruit canned fruit and applesauce fruit and vegetable juices green salad with no dressing baked potato, plain	celery with peanut butter green salad with 2 tsp. dressing baked potato with 1 tsp. margarine	avocado coconut sunflower and pumpkin seeds walnuts, pecans, and macadamia nuts olives french fries green salad with 1 T. dressing baked potato with everything
Milk & Dairy Products	skim or nonfat milk hot chocolate with nonfat milk soft drink with ice milk	low-fat milk or or buttermilk low-fat chocolate milk milkshake made with ice milk	whole milk or buttermilk milkshake, any flavor chocolate pudding

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FOOD ITEM	LOW-FAT	MODERATE-FAT	HIGH-FAT
Milk & Dairy Products *(continued)*	frozen yogurt bar sherbet or ice milk low-fat cottage cheese & bagel	low-fat yogurt grilled low-fat cheese sandwich	regular yogurt grilled cheese sandwich cream cheese & bagel
Meats	turkey, sliced chicken, sliced tuna, plain (water packed)	tuna (water packed) and 1 tsp. mayonnaise fried chicken, no skin tostada or taco pizza, vegetarian hamburger	hot dog bologna & other luncheon meats peanut butter sandwich bacon, lettuce & tomato sandwich fried chicken or fish cheeseburger pizza with meat
Grains & Cereals	hot cereal with lowfat or nonfat milk english muffin or bagel dinner roll, plain tortillas (corn or flour) (made without oil or lard) bread sticks	granola dry cereal with whole milk muffin, homemade saltine crackers popcorn, oil popped pancakes or waffle with margarine tortilla (corn or flour) (made without oil or lard)	muffin, croissant, or crescent roll tortilla or potato chips HiHo, Ritz, or Triscuits crackers popcorn, oil popped with margarine popcorn, microwave

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FOOD ITEM	LOW-FAT	MODERATE-FAT	HIGH-FAT
Grains & Cereals *(continued)*	rice cake		
	puffed cereals, shredded wheat, bran cereals & other dry cereals	granola	
	whole wheat bread, french bread, & enriched white	cheese bread	
	popcorn, air popped		
Sweets & Fats	gum drops jelly beans	granola bar	chocolate candy peanut cookies
	graham crackers	animals cookies ginger snaps, & fig bars	chocolate chip cookies donut
	angel food cake (no icing)	peanut brittle sponge cake (no icing)	chocolate, yellow, or white cake with icing
	fudgesicle & popsicle		cupcake with icing pound cake
	gelatin dessert	mayonnaise, light	carrot or banana nut cake
	non-fat dressing	margarine, diet	salad dressings such as French, Italian or Blue Cheese
	low-calorie Thousand Island, Italian or French dressing		margarine or butter cooking oil
	ice milk sherbet	ice cream	ice cream (rich)

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HANDOUT 2

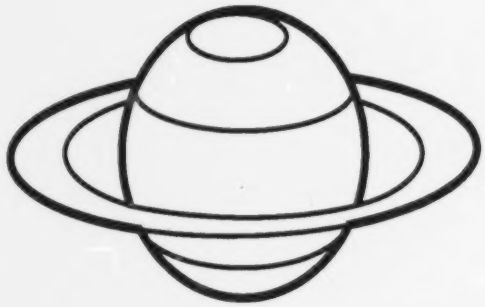
For leader and member

You and your crew are planning a trip to Lowfaturn, a newly discovered planet. But to survive on Lowfaturn, visitors must be able to select and eat a diet low in fat. Thus, your crew must begin today to know how to avoid too much fat in their diets.

To learn how to survive on Lowfaturn, play the game.

RULES

1. Select teams or play as individuals.
2. The object of the game is to be the first one to Lowfaturn.
3. Take turns in a clockwise order. The youngest member may begin first.
4. Use buttons, beans, noodles, or other similar items as individual markers.
5. One turn consists of rolling the dice and moving the designated number of spaces toward Lowfaturn. You may move in any direction. However you can only land on food items that are low or moderate in fat.



6. If you are unable to land on a low- or moderate-fat food, you cannot move.
7. Refer to handout 1, ***High or Low?*** , to determine which foods are low, moderate, or high in fat.
8. The first player or team to land on Lowfaturn wins or is ready to travel to this newly discovered planet.

ALTERNATE WAYS TO PLAY

A. Play the game without using handout 1. Have someone be the judge to check if the move is to a food low or moderate in fat.

B. Play the game by moving to foods low in fat.

C. Play the game by moving in one direction or in a straight line for each roll of the dice.

D. Copy the gameboard on to bedsheets or paper to lay on the floor or write with chalk on cement or blacktop. The individual players become the markers moving from food item to food item on their travels to Lowfaturn.

E. Create your own gameboard by having players list their favorite foods. In a class situation, have each student list one food low in fat and one high in fat.

HANDOUT 3
Gameboard

For the members

LOWFATURN

SAFELY LAND HERE!	Jelly Beans	Granola Bar	Milkshake
Tuna (water packed)	Baked Potato	Chocolate Candy Bar	Gelatin Dessert
Yogurt (regular)	Milk (whole)	Angel Food Cake	Walnuts
Saltine Crackers	Fried Chicken	Bologna (without skin)	Cottage Cheese with a Bagel
Chocolate Chip Cookies	Tuna (oil packed)	Popcorn (air-popped)	Corn on the Cob
Margarine or Butter	Popcorn (oil-popped)	Taco	Muffin
Milk (skim)	Milkshake (made with ice milk)	French Fries	Pizza (with meat)
Cupcake with icing	Tortillas (made without oil or lard)	Cheeseburger	Donut

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HANDOUT 3
Gameboard *(continued)*

Muffin (homemade)	Peanut Brittle	Vegetable Juice	Grilled Cheese Sandwich
Lettuce & Tomato Sandwich	Frozen Yogurt Bar	Potato Chips	Milkshake (made with ice milk)
Yogurt (low fat)	Pizza (vegetarian)	Olives	Hot Dog
Dry Cereal	Avocado	Sunflower Seeds	Chicken (fried)
Green Salad (with 2 tsp. dressing)	Celery or Carrots	Applesauce	Pickle
Fruit Juice	Margarine (diet)	Baked Potato (with everything)	Water
Apple or Orange	Custard	Rice Cake	Peanut butter Cookie
Chocolate Milk (made with skim milk)	French Dressing	HiHo, Ritz, or Triscuits Crackers	**EARTH** ALL SYSTEMS GO! PLACE YOUR MARKERS HERE!

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WATER YOU THINK

Topic — Water: we need it in space and on earth.

Members Should Be Able To

- Answer a minimum of eight questions with 100% accuracy.
- Discuss the role of water in the human body.
- Recognize that fruits and vegetables have a high water content.
- Explain how fruits and vegetables are preserved for space travel by dehydration and irradiation.

You Will Need

For each member

- "Water You Think" game cards
- "Water You Think" game directions
- scissors

Background Information

Read the material that accompanies this activity:

- Getting the most from the most essential nutrient
- Spectrum of dehydration

Information to support the correct answer for each game question is included on each game card. Use the yes/no or true/false answers for the game, and the detailed answers for group discussions before and after the game.

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What To Do

1. Before meeting with members, cut out the 48 game cards. Group the game cards by age: 9 years and 13 years.
2. Read the game directions to the group at the beginning of the game.
3. Play the game according to the directions.

Water You Think: Game Directions (30-50 minutes)

1. Members are assigned to a group. One member shuffles the cards and places them in a pile, face down, in the middle of the playing area. The youngest member in each group starts by drawing the top card, then reading the question to the member to the left. (All questions can be answered with a yes, no, true, or false.)
2. The member who answers the question correctly keeps the card and receives another question from the member who asked the first question. If the member answers correctly a second time, the member keeps the card, but the turn is over. Play continues as the next player draws a card and asks a question of the player on the left.

   If an incorrect answer is given, the reader reads the correct answer and returns the card to the bottom of the drawing pile. The reader should only read the yes or no, true or false section of the answer. The rest of the information in the answer format is provided as added information for group discussions before and after the game. Play continues to the left.
3. The game ends when a player has collected 8 cards.

Variations

- The game may also be played by using teams of players. In the "team" variation the leader asks all the questions. Since the leader is available to act as referee, detailed answers in addition to yes/no may be requested.

  The leader shuffles the cards and alternately asks each team the question on the top card. Team members may discuss the question/answer and give one answer as a group, or take turns answering the questions individually. When the team answers correctly, they keep the card as a means of keeping score. Incorrectly answered questions are returned to the bottom of the leader's pile of cards.

  The first team to collect 8 cards wins the game. (This direction can be changed by the leader to meet the needs of the group.)
- This game can also be played at home, or in a car with family members.

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Getting the most from the most essential nutrient

No chart will tell you exactly how much you need, but you cannot survive without it. In fact, while you can live without most vitamins and minerals for extended periods of time, just a few days without this nutrient will surely result in death. The nutrient, of course, is water, that colorless, calorieless compound of hydrogen and oxygen that virtually every cell in the body needs to survive. Even tissues that are not thought of as "watery" contain large amounts of this substance. Water makes up about three-fourths of the brain and muscles, for instance. And bone, which is seemingly dry, is more than one-fifth water. Over-all, water accounts for about half to two-thirds of the body makeup. Put another way, we each have about 40 to 50 quarts, enough to fill more than a couple of sinks. Men contain more than women because they have proportionately less fat, and lean tissue holds more water than fat tissue.

A discussion of the role of water as a nutrient could easily fill a book. One of water's many essential tasks is to carry nutrients and oxygen to all parts of the body through the blood and the lymphatic system. In addition, it plays an important part in maintaining body temperature; the heat released when we lose water via the evaporation of perspiration helps keep the body cool. Water also removes metabolic waste by way of urine and sweat, lubricates the joints, surrounds and protects an unborn child, gives "form" to the cells, and serves as the medium for thousands of life-supporting chemical reactions that are constantly taking place within us.

The average adult consumes, and excretes, about two and a half to three quarts of water a day. People who live in hot climates or whose jobs or hobbies involve strenuous physical activity require more. Thirst is generally a good indicator of when the body needs to replenish its water supply. It is regulated by the sodium concentration of the blood; when the sodium (or salt) level of blood rises, "receptors" in the brain's hypothalamus trigger the thirst sensation. In addition, "thirsty" blood draws water from the salivary glands, making the mouth feel dry.

Although thirst goes a long way in insuring that we have enough water, it is not a perfect mechanism. It is quite possible that a person will drink enough fluids to quench his dry or parched throat but not enough to put back into his body what he needs. That is the reason people are advised to drink six to eight 8-ounce glasses of fluids a day, thirsty or not. People on high-protein diets also have to take in more water than they thirst for–perhaps eight to 10 glasses a day–so the kidneys will have enough to flush out the waste products of protein metabolism. Drinking past the point of thrist also reduces the risk of dehydration for those who live in extremely hot climates as well as for athletes and laborers who sweat excessively. Under ordinary circumstances, drinking more water than you need can't hurt. It's almost impossible to take in too much, because the body is efficient at getting rid of what it doesn't need.

Most of the water we take in comes from beverages, including juice, milk, and soft drinks. Alcoholic beverages as well as tea and coffee also supply water, but because they are diuretics, they increase water output and can actually raise water needs.

Although we get most of our water from liquids, solid foods also contribute significantly to our daily intake. Most fruits are more than 80 percent water, and even foods that aren't "juicy" or "moist" supply us with large amounts. Water makes up 60 percent of cooked lean beef, for instance, while bread is a third water and butter is roughly 15 percent water. Nothing is more surely water, however, than water itself. But is all water the same? Yes and no.

Although water is always two parts hydrogen to one part oxygen, its composition also depends on where it comes from and how it's processed. It can be hard or soft, carbonated or still, "natural" or "modified." The source of the water may be buried deep within the earth's surface or a reservoir or pond. In addition, water has varing amounts of bacteria and contaminants like arsenic and lead. And water suppliers may choose whether or not to add fluoride and /or other substances.

Public water systems provide 90 percent of the U.S. population with drinking water. Close to half of our municipal tap water comes from surface water, such as rivers and streams. The rest comes from ground water, including wells, springs, and aquifers.

From Tufts University Diet and Nutrition Letter, Vol. 4., Oct. 1986

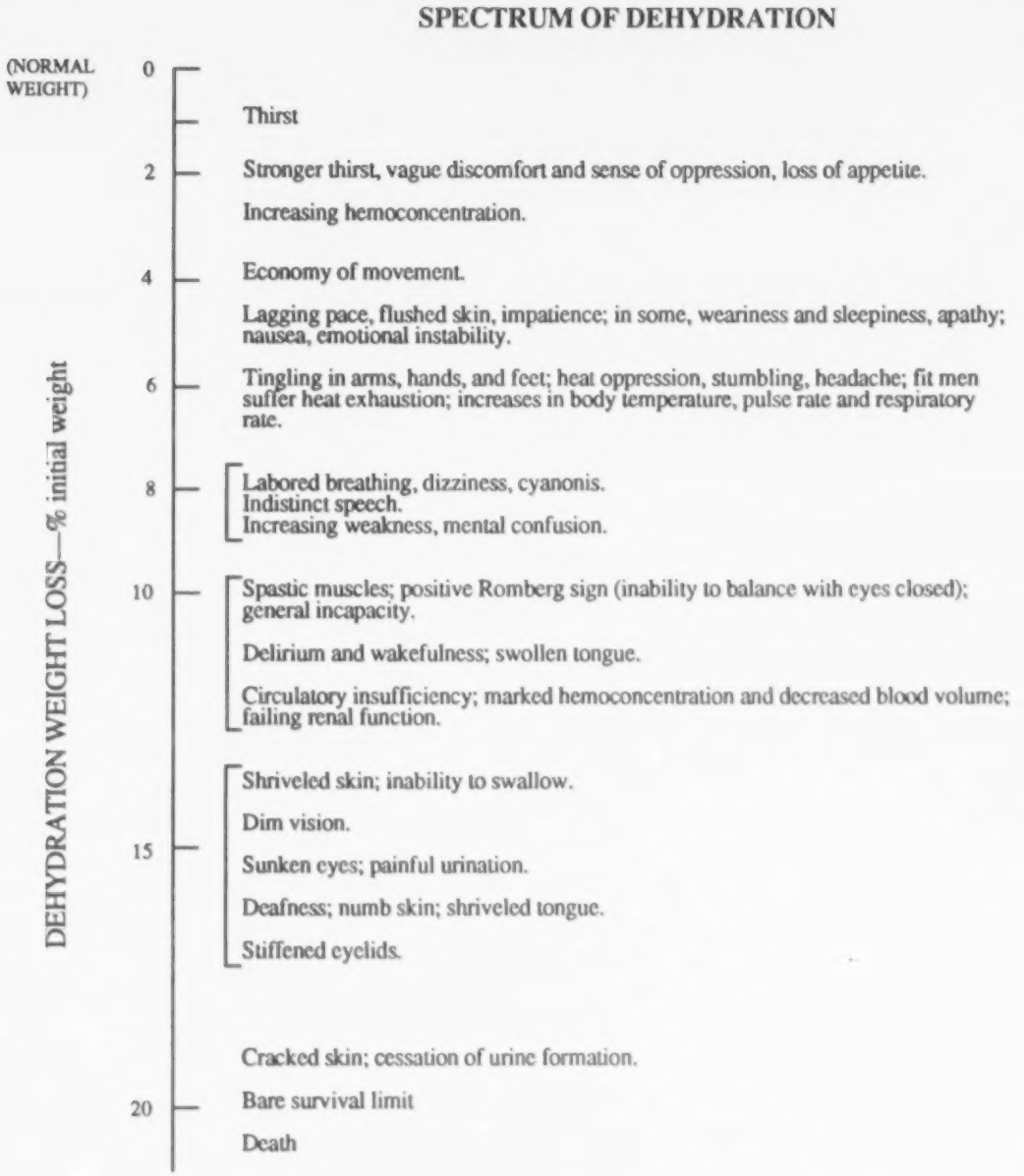
SPECTRUM OF DEHYDRATION
(NORMAL WEIGHT)
0
Thirst
2
Stronger thirst, vague discomfort and sense of oppression, loss of appetite.
Increasing hemoconcentration.
4
Economy of movement.
Lagging pace, flushed skin, impatience; in some, weariness and sleepiness, apathy; nausea, emotional instability.
6
Tingling in arms, hands, and feet; heat oppression, stumbling, headache; fit men suffer heat exhaustion; increases in body temperature, pulse rate and respiratory rate.
8
Labored breathing, dizziness, cyanonis.
Indistinct speech.
Increasing weakness, mental confusion.
10
Spastic muscles; positive Romberg sign (inability to balance with eyes closed); general incapacity.
Delirium and wakefulness; swollen tongue.
Circulatory insufficiency; marked hemoconcentration and decreased blood volume; failing renal function.
15
Shriveled skin; inability to swallow.
Dim vision.
Sunken eyes; painful urination.
Deafness; numb skin; shriveled tongue.
Stiffened eyelids.
Cracked skin; cessation of urine formation.
20
Bare survival limit
Death
DEHYDRATION WEIGHT LOSS—% initial weight

Figure 13-5 Spectrum of dehydration. [After Roth, E.M. (ed.): Compendium for Development of Human Standards in Space System Design, Vol. 3 NASA 1967.]

In: ***Nutrition and Physical Fitness,*** 11th Edition, George M. Briggs and Doris H. Calloway, 1984, p. 319.

Water You Think Game Cards

Q: Vegetables and their juices are a good source of water. T or F?

A: **TRUE**. Fresh vegetables and vegetable juices average about 90% water.

AGES 9 AND UP

Q: Fresh vegetables are easy to bring along on a two-week space ride. T or F?

A: **FALSE**. Since vegetables contain a lot of water, they are bulky in space. Weight and space are precious. Vegetables are dehydrated before they are packed for space flight. Fresh vegetables are 90% water.

AGES 9 AND UP

Q: An excessive loss of water during a space walk can make you tired. T or F?

A: **TRUE**. Fatigue, headaches, apathy, flushed skin, dizziness, and mental confusion are among the common symptoms of an excessive water loss from your body. This process is called dehydration.

AGES 9 AND UP

Q: A crew member can go for two days without water. T or F?.

A: **TRUE**. Crew members and "earthnauts" can survive a few days without water, but can survive as long as two weeks without food.

AGES 9 AND UP

Q: Design your own ***Water You Think*** question.

A:

AGES 9 AND UP

Q: Design your own ***Water You Think*** question.

A:

AGES 9 AND UP

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Water You Think Game Cards

Q: In space, perspiration is the process by which your body controls its temperature. T or F?

A: **TRUE**. Perspiration or sweat acts as a cooling system when your body is hot. This is just as true on earth as in space.

AGES 9 AND UP

Q: Bones contain no water. T or F?

A: **FALSE**. Bones are about 33% water whether you are an "earthnaut" or a space shuttle member.

AGES 9 AND UP

Q: Strenuous exercise like a walk in space or a jog on earth can result in a large loss of body water. T or F?

A: **TRUE**. Water is lost through the pores of the skin as your body tries to cool itself down.

AGES 9 AND UP

Q: Fruit contains very little water. T or F?

A: **FALSE**. An apple is 84% water. Bananas are 75% water. Peaches are 90% water.

AGES 9 AND UP

Q: Soft drinks containing caffeine will give you quick energy. Y or N?

A: **NO**. These drinks increase loss of body water and the possibility of dehydration.

AGES 9 AND UP

Q: Water makes up about 45-65% of red meats. T or F?

A: **TRUE**. Water makes up about 3% of nuts, 30% of bread, 75% of eggs and 85% of milk.

AGES 9 AND UP

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Water You Think Game Cards

Q: One way to dehydrate food in preparation for space travel is called freeze drying. T or F?

A: **TRUE**. Vegetables are cooked, placed in a freezer and rapidly frozen. The frozen vegetables are placed in a freeze dryer where the water, now ice, is converted into a vapor. This vapor collects at the bottom of the chamber as ice, leaving the vegetables with no water content. This process takes 2-3 days.

AGES 9 AND UP

Q: All dehyudrated foods aboard the shuttle are packaged in special containers. T or F?

A. **TRUE**. The special containers allow water to be conveniently added to the dehydrated food when meal time arrives. A septum is located in the corner of each container where water is inserted . The containers work for both solid and liquid foods. A straw is inserted into the septum if the food is a beverage.

AGES 9 AND UP

Q: Water is not an essential nutrient needed by your body. T or F?

A: **FALSE**. Water is an essential nutrient needed by your body. Other major groups of nutrients are carbohydrates, fats, proteins, vitamins and minerals.

AGES 9 AND UP

Q: One way to preserve food for space travel is irradiation. T or F?

A: **TRUE**. Several foods eaten aboard the shuttle have been irradiated. An irradiated food has been exposed to rays from radiation sources. Insects, bacteria, fungus and mold are killed by the radiation. The food remains safe to eat and stays fresh longer. The food does not become radioactive.

AGES 9 AND UP

Q: Dehydration of food means the removal of water from the food. T or F?

A: **TRUE**. The process of dehydration of food enables many foods to be preserved safely for space flight. By removing water from food, weight as well as volume is saved. Both are important in the space shuttle. Over half of the foods on the shuttle are dehydrated.

AGES 9 AND UP

Q: Rehydration of foods means the removal of water. T or F?

A: **FALSE**. Rehydration is the process of adding water back to foods to make them ready to eat.

AGES 9 AND UP

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Water You Think Game Cards

Q: Dehydration of your body means an excessive loss of body water. T or F?

A: **TRUE**. Your body cannot function without water. In fact it needs a lot to operate at its peak. Your body is hydrated when it has enough water to operate at peak performance–this usually means 6-8 glasses of liquid a day.

AGES 9 AND UP

Q: Most dried fruits are 10-20% water. T or F?

A: **TRUE**. Before drying, these fruits are usually more than 85% water.

AGES 9 AND UP

Q: When vegetables contain no more than 5% moisture, they are dry. T or F?

A: **TRUE**. Fresh vegetables are usually 90% water. They are dehydrated at a 5% moisture level and ready for space flight or a 4H backpacking trip.

AGES 9 AND UP

Q: Snow is made up of 100% water. T or F?

A: **TRUE**. Snow is a form of frozen water.

AGES 9 AND UP

Q: Dehydration of your body makes you less physically fit. T or F?

A: **TRUE**. On earth and in space, dehydration affects the chemical reactions in the cells of your body. For example, your muscles do not work as well when your body is dehydrated.

AGES 9 AND UP

Q: Water is made up of air. T or F?

A: **FALSE**. However, air usually contains some water in the forms of solid (ice crystals), liquid (rain) or gas (water vapor).

AGES 9 AND UP

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Water You Think Game Cards

Q: Water takes the shape of its container. T or F?

A: **TRUE**. Water is a liquid. Liquids always take the shape of their containers. Gases also take the shape of their container. Solids, like ice, do not.

AGES 9 AND UP

Q: All water is safe to drink. T or F?

A: **FALSE**. Some water is contaminated and not safe to drink.

AGES 9 AND UP

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Water You Think Game Cards

Q: Design your own ***Water You Think*** questions.

A:

AGES 9 AND UP

Q: Design your own ***Water You Think*** questions.

A:

AGES 9 AND UP

Q: Design your own ***Water You Think*** questions.

A:

AGES 9 AND UP

Q: Design your own ***Water You Think*** questions.

A:

AGES 9 AND UP

Q: Design your own ***Water You Think*** questions.

A:

AGES 9 AND UP

Q: Design your own ***Water You Think*** questions.

A:

AGES 9 AND UP

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Water You Think Game Cards

Q: Teens who lose 2% of their body weight as water are said to be suffering from mild dehydration. T or F?

A: **TRUE**. A 1% weight loss due to water results in thirst. For the 75-pound member, this means a 3/4-pound water loss. A 2% weight loss due to water results in stronger thirst, discomfort and increased heart rate. Ability to work and think deteriorates.

AGES 13 AND UP

Q: You are now on a space flight. Your blood is no longer 78% water as was on Earth. T or F?

A: **FALSE**. In a healthy state, 78% of your blood is water no matter where you are.

AGES 13 AND UP

Q: Water is close to being a "universal solvent." T or F?

A: **TRUE**. Water dissolves more materials than any other substance—including acids.

AGES 13 AND UP

Q: Acid rain is a threat to our health because it can contaminate our water supplies. T or F?

A: **TRUE**. Acid rain has become a world-wide concern. It threatens agriculture as well as our health.

AGES 13 AND UP

Q: In space, your body is about 60 to 70% water. T or F?

A: **TRUE**. About 60 to 70% of your body is made up of water whether you are on earth or in space. The more physically fit you are the higher percentage of water in your body. Muscles contain a high percentage of water. Fat does not.

AGES 13 AND UP

Q: Water for the rehydration of foods aboard the shuttle is a by-product of generating electricity. T or F?

A: **TRUE**. Electricity aboard the shuttle is generated by fuel cells which combine hydrogen and oxygen together. Water is a by-product. This water is used for drinking, washing, cleaning up, and rehydrating food.

AGES 13 AND UP

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Water You Think Game Cards

Q: A 20% loss of body weight as water can lead to death. T or F?

A: **TRUE**. For the 75-pound member, this means 15 pounds of water.

AGES 13 AND UP

Q: Scientists use the symbol H_2O to represent water. T or F?

A: **TRUE**. H stands for hydrogen. O stands for oxygen. The 2 means two atoms of hydrogen.

H_2O represents two atoms of hydrogen and one of oxygen per molecule of water.

AGES 13 AND UP

Q: Warm water can hold more dissolved oxygen (O_2) than cold water. T or F?

A: **FALSE**. The molecules of water are moving faster in warm water so the oxygen gas bubbles out into the air.

AGES 13 AND UP

Q: Water is the only compound that is less dense as a solid than as a liquid. T or F?

A: **TRUE**. Solid water is called ice. That's why ice floats in water. Ice is less dense than water. Try this: Add some ice cubes to a bowl of water, Do they sink or float?

AGES 13 AND UP

Q: A 10% loss of body weight as water can cause you to be seriously ill. T or F?

A: **TRUE**. For the 75-pound member, this amounts to a 7-pound water loss. Delirium, spastic muscles, mental confusion, heat oppression and indistinct speech occurs.

AGES 13 AND UP

Q: Drinking water before eating and eating slowly may be helpful to dieters. T or F?

A: **TRUE**. Drinking water helps a person feel full for a short time. Eating slowly may help them eat less.

AGES 13 AND UP

4H-EFNEP
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Water You Think Game Cards

Q: The faster you lose weight the better. T or F?

A: **FALSE**. Quick weight loss usually means a loss of body water, not body fat. Thus, loss is temporary—until your next glass of water or fluid. Generally, the slower you lose weight the longer you will keep it off. Aim for a weight loss of no more than 1-2 pounds per week.

AGES 13 AND UP

Q: During space flight do crew members need to take salt tablets when they sweat? Y or N?

A: **NO**. A normal diet will provide more than enough salt. Taking salt tablets can dehydrate the body. This is dangerous both in space and on earth.

AGES 13 AND UP

Q: Will "sports drinks" prevent dehydration for a crew member during space travel. Y or N?

A: **NO**. Fancy "sport drinks" and sugary drinks are less effective in rehydrating the body after exercise. They attract and hold water in the intestines. Water can't get to the dehydrated cells where it is needed. Dehydrated muscle cells lead to muscle cramping. Mix 1 part fruit juice with 2 parts water or drink plain water to prevent dehydration.
AGES 13 AND UP

Q: On earth and in space, thirst is regulated by an area in your stomach. T or F?

A: **FALSE**. Thirst is regulated by an area in your brain.

AGES 13 AND UP

Q: Design your own ***Water You Think*** questions.

A:

AGES 13 AND UP

Q: Design your own ***Water You Think*** questions.

A:

AGES 13 AND UP

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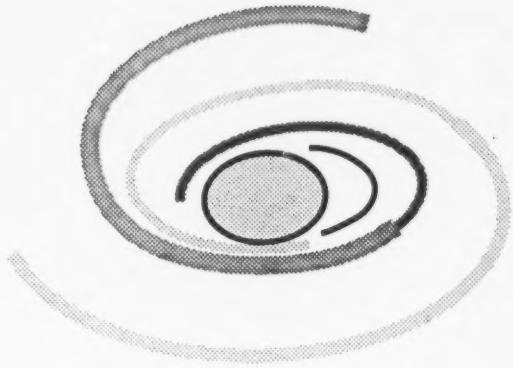
SENSORY EXPERIMENTS

Topic — Your Senses and food; Food rehydration in space

Members Should Be Able To

- Understand how the four senses of taste, see, feel, and taste influence food likes and dislikes.
- Make a decision about food preference.
- Recognize that individuals have different food likes and dislikes.
- Rehydrate dried fruit.



You Will Need

For each member or team

- fresh fruit *and* store-bought dried or homemade dried fruit of the same type such as apples, apricots, pears, etc.
- a container and water to cover dried fruit for rehydrating the dried fruits
- saucepans and a stove or hot plate, if simmering is desired
- handout, *"Sensory Experiments,"* and pencils

Background Information

This activity is appropriate for all ages. Members may do it individually or as a team. Members will compare store-bought or homemade dried fruit and fresh fruit of the same type, using their senses of sight, touch, smell, and taste. They will record their results and determine their preferences.

Members will also explore how to rehydrate or add the water back to dried fruit, gaining additional knowledge about dehydration or drying as a method of food preservation.

What To Do

1. Select fresh and dried fruit, homemade or store-bought, of the same type.
2. Provide each member or team with the handout.
3. Have members describe dried fruits; rehydrate dried fruits; and compare with fresh.
4. Have members determine which fruit—dried, rehydrated or fresh—they prefer.
5. Compare results.

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SENSORY EXPERIMENTS

You are aboard your spacecraft and it is time for a snack. You have a choice to eat your fruit as a dried food or rehydrate it. What is your preference?

Step 1: Select fresh and dried fruit, store-bought or homemade, of the same type such as apples, apricots, pears, etc. Answer these questions.

1. Describe the color, texture, smell, and taste of the dried fruit.

Color _____

Texture or feel _____

Smell _____

Taste _____

2. Describe the color, texture, smell, and taste of the fresh fruit.

Color _____

Texture or feel _____

Smell _____

Taste _____

Step 2: Rehydrate several pieces of the dried fruit. Place the dried fruit in a container and add just enough water to cover it. Too much water can result in vitamin and mineral losses. The fruit will usually become plump in 1 to 2 hours or when most of the water has been absorded. Overnight soaking may be necessary for large or whole pieces of fruit. Be sure to refrigerate if you plan to soak for longer than 2 hours.

Another way to rehydrate is to cook the dried fruit in water or fruit juice. Add the fruit to boiling water and simmer for 10 to 15 minutes.

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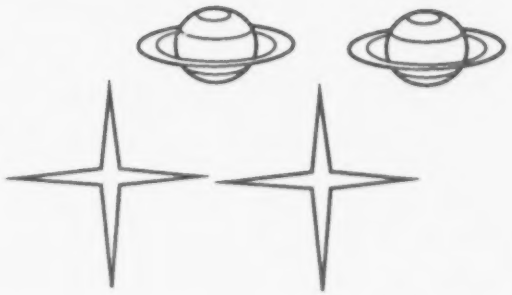
One-half cup of dried fruit is usually equivalent to 1 cup of fresh fruit.



Answer these questions.

3. Describe the color, texture, smell and taste of the rehydrated dried fruit.

Color _____

Texture or feel _____

Smell _____

Taste _____

4. Did the color or texture of the dried fruit change after rehydrating?

5. Does the dried fruit smell the same before and after rehydrating?

6. Eat some dried fruit before rehydrating and compare its taste to the rehydrated fruit. Describe the difference and similarities.

7. Which fruit, before or after rehydration, do you like best for a snack?

8. How does the rehydrated fruit compare to the fresh fruit?

9. Share your comparisons with others. How do you differ? How are you the same?

10. How many members like the dried fruit? How many like the rehydrated fruit the best? How many like the fresh fruit?

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THE SEARCH FOR SPACE FOOD

Topic — Label Reading Skills

Members Should Be Able

- Identify the information on every food label
- learn that many products in our grocery stores today use space technology in preparing, preserving and/or packaging

You Will Need

For each member or team

- Samples of food labels
- Handout #1, "The Search for Space Food," and pencils
- Clip board or a hard surface for writing

Background Information

This activity is appropriate for all ages. Members may do it individually or as part of a team. Members learn how to read a food label. They visit a grocery store to discover dried foods sold "as is" or as an ingredient in a product. They explore how the food product is prepared for eating. They record their findings and share this information with others.

Dehydration has become a popular method of processing foods because of the long term storage factor and the convenience to prepare.

Members will be discovering how dried food is used in a variety of products. Label information on preparing the food for eating will provide them with additional information about the different methods of dehydrating dried foods.

Food labels tell you a lot about the contents of a package. The law requires all food labels to include the following:

- The name of the food
- What form or style the food is. Some examples include: "condensed" soup, "evaporated" milk or peaches "packed in juice."
- Weight of contents
- The name and address of the manufacturer, packer, or distributor

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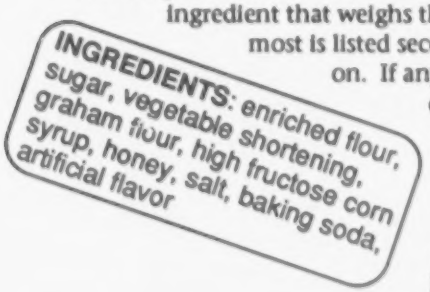
A label is important because it tells you if you are buying cream-style corn or apricot halves, if the canned pears are packed in water or in light or heavy syrup, and much more.

On nearly every label, you will find

- Ingredients used in the food. The ingredient that weighs the most is listed first, the ingredient that weighs the second most is listed second, and so on. If any colorings or additives are included in the package, they will be listed.


INGREDIENTS: enriched flour, sugar, vegetable shortening, graham flour, high fructose corn syrup, honey, salt, baking soda, artificial flavor

- Some products do not list ingredients. These products—like mayonnaise, ice cream and jam— must follow a recipe that's set by the U.S. government. They are called STANDARD OF IDENTITY products. Only the ingredients that are different from the government recipe must be listed on the label.

On many labels, you will find nutrition information. When nutritional claims are made such as low calorie or low fat or if nutrients are added (fortified or enriched), the food label must give the following information:

- Serving size
- Servings per container
- Calories
- Percentages of U.S. Recommended Daily Allowances (U.S.RDA) for 11 nutrients
- Protein
- Carbohydrate
- Fat

What To Do

1. Discuss with members what a food label tells them about the contents of a package.
2. Make arrangements (permission of store owner and transportation) to visit a grocery store.
3. Using Handout #1, "The Search for Space Foods", have members discover dried foods "as is" or as an ingredient in a product.
4. Record findings and share with others.

NUTRITION INFORMATION PER SERVING AS PACKAGED

SERVING SIZE: 3.3 OZ.		SERVINGS PER PACKAGE: 3	
CALORIES	25	CARBOHYDRATE	5G.
PROTEIN	2G.	FAT	0

% OF U.S. RECOMMENDED DAILY ALLOWANCES (U.S. RDA)

PROTEIN	4%	CALCIUM	2%
VITAMIN A	15%	IRON	4%
VITAMIN C	100%	VITAMIN B-6	6%
THIAMINE	4%	PHOSPHORUS	4%
RIBOFLAVIN	4%	MAGNESIUM	4%
NIACIN	2%		

CONTAINS 0.9% NON-NUTRITIVE CRUDE FIBER (0.9 GRAM PER SERVING).

INGREDIENTS: BROCCOLI FLORETS, CAULIFLOWER FLORETS, RED PEPPERS

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The Search for Space Food

Name: _____ Date: _____

You and your crew are gathering food for your mission into space. But for this trip you would like to try some new foods. Take a trip to the grocery store to discover foods which are lightweight, low in volume and require no refrigeration. In addition, you are looking for products which are nutritious, and are simple to prepare for eating. Dried foods meet these requirements. They are excellent products for your flight into space.

Step 1: At the grocery store, look for food products which are dehydrated and need added water before eating. Examples are soups, casseroles or side dishes, powdered drinks, herbs, etc.

Step 2: Explore your local grocery store by reading labels to learn which foods are dehydrated. Read the list of ingredients and the directions of how to prepare the product.

How many can you find? Record you results below.

FOOD	INGREDIENTS	HOW DO YOU PREPARE THE FOOD FOR EATING?
1.		
2.		
3.		

Step 3: Share your information about dried foods with other crew members.

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BLAST OFF

Topic — Rocket building

Members Should Be Able To

- prepare a model rocket for launch
- understand and abide by the *Model Rocket Safety Code*
- list the phases of flight
- develop life skills in working together, understanding and following directions

You Will Need

- large field away from power lines, trees, and low flying aircraft
- model rocket launching system
- model rocket that has been assembled and painted
- model recovery wadding for each rocket
- recommended size rocket engine and igniters for each model rocket

Background Information

This activity is appropriate for 9 year olds and older members. Adult supervision is required. Model rockets can reach speeds in excess of 400 MPH. If model rockets are improperly launched, dangerous situations may occur!

The time required is approximately 1 hour to launch 10 to 15 model rockets.

It is important to select a launch site that is free of dried weeds or brown grass. There should be no or little wind and good visibility. The larger the launch area, the better your chances of recovering the rockets. Football fields and playgrounds or open plowed fields are ideal. Most sites will need the approval of the local fire department and owner of the property. Plan well in advance.

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What To Do

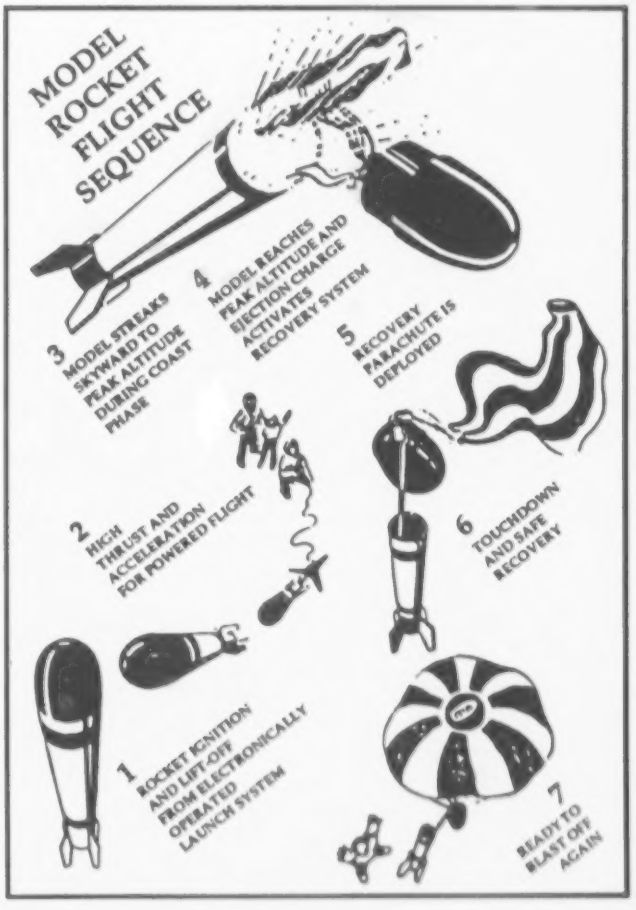
Follow the directions enclosed with each model rocket kit in preparing the model rocket and rocket engine for launching. The model rocket launching system will also have directions for assembly. It is best to assemble the launching pad and test its electrical source before members meet to launch their rockets.

Review the *Model Rocket Safety Code* with the participants. You may want to identify who will launch first, etc. before arriving at the launch site. For extra safety, only one rocket should be launched at a time and only the owner of the rocket should be eligible to retrieve. Stress the importance of not trying to catch the rocket in downward flight . . . let it hit the ground before touching it! Also designate a safety area for everyone to stay during launching.

❖ ❖ ❖

Discussion of The Flight Phases

1. Rocket ignition and lift-off from electrically operated launch system
2. High-thrust and acceleration for powered flight
3. Model streaks skyward to peak altitude during coast phase
4. Model reaches peak altitude and ejection charge activates recovery system
5. Recovery system is deployed (parachute, streamer or tumble recovery)
6. Touch down and safe recovery
7. Ready to blast off again!


MODEL ROCKET FLIGHT SEQUENCE
3 MODEL STREAKS SKYWARD TO PEAK ALTITUDE DURING COAST PHASE
4 MODEL REACHES PEAK ALTITUDE AND EJECTION CHARGE ACTIVATES RECOVERY SYSTEM
5 RECOVERY PARACHUTE IS DEPLOYED
2 HIGH THRUST AND ACCELERATION FOR POWERED FLIGHT
6 TOUCHDOWN AND SAFE RECOVERY
1 ROCKET IGNITION AND LIFT-OFF FROM ELECTRONICALLY OPERATED LAUNCH SYSTEM
7 READY TO BLAST OFF AGAIN

Summary of Flight Phases

1. Ignition and lift off
2. Acceleration
3. Peak altitude (coast)
4. Recovery system deployed
5. Recovery
6. Touch down

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Model Rocketry Safety Code

1. CONSTRUCTION — My model rockets will be made of lightweight materials such as paper, wood, rubber, and plastic without any metal as structural parts.
2. ENGINES — I will use only pre-loaded factory-made NAR Certified model rocket engines in the manner recommended by the manufacturer. I will not alter or dismantle model rocket engines or their ingredients in any way or attempt to reload these engines.
3. RECOVERY— I will always use a recovery system in my rockets that will return them safely to the ground so that they may be flown again. I will use only flame-resistant recovery wadding in my rockets.
4. WEIGHT LIMITS — My model rocket will weigh no more than 1500 grams (53 oz.) at lift-off, and the engines will contain a total of no more than 125 grams (4.4 oz.) of propellant. My model rockets will weigh no more than the engine manufacturer's recommended maximum lift-off weight for the engines used or will use the engines recommended by the manufacturer for my rocket.
5. STABILITY— I will check the stability of my model rockets before their first flight, except when launching models of already proven stability.
6. PAYLOADS — My model rockets will never carry live animals or payloads that are intended to be flammable or explosive.
7. LAUNCH AREA — I will launch my model rockets outdoors in a cleared area, free of tall trees, power lines, and buildings. I will ensure that people in the vicinity are aware of the pending rocket launch and are in a position to see the rocket's lift-off before I begin my audible 5-second countdown.
8. LAUNCHER — I will launch my model rockets from a rod or other device which provides rigid guidance until the rocket has reached a speed adequate to ensure a safe flight path. To prevent accidental eye injury, I will always place the launcher so that the end of the rod is above eye level or will cap the end of the launch rod when approaching it. I will cap or disassemble my launch rod when not in use and will never store it in an upright position. The launch device will have a jet deflector to prevent the engine exhaust from hitting the ground directly. I will always clear the area around my launch device of brown grass, dry weeds, and other easy-to-burn materials.
9. IGNITION SYSTEM — The system I use to launch my model rockets will be remotely controlled and electrically operated and will contain a launching switch that will return to "off" when released. The system will contain a removable safety interlock in series with this firing switch. When launching, all persons will remain at least 15 feet away from any model rocket when igniting engines totalling 30 N-sec. of total impulse or less and at least 30 feet when igniting engines totalling more than 30 N-sec. total impulse. I will use only electrical igniters which will ignite my rocket engine within one second of actuation of the launching switch.
10. LAUNCH SAFETY— I will not let anyone approach a model rocket on a launcher until I have made sure that the safety interlock has been removed or the battery has been disconnected from the launcher. In the event of a misfire, I will wait one minute before allowing anyone to approach the launcher.
11. FLYING CONDITIONS — I will launch my model rocket only when the wind is less than 20 miles per hour, and under conditions where the model will not fly into clouds, fly near aircraft in flight, or be hazardous to people or property.
12. PRE-LAUNCH TEST—When conducting research activities with unproven designs or methods I will, when possible, determine their reliability through pre-launch tests. I will conduct launchings of unproven designs in complete isolation from persons not participating in the actual launching.
13. LAUNCH ANGLE — I will not launch rockets so their flight path will carry them against targets. My launch device will be pointed within 30 degrees of vertical. I will never use model rocket engines to propel any device horizontally.
14. RECOVERY HAZARDS — If a model rocket becomes entangled in a power line or other dangerous place, I will not attempt to retrieve it.

APPENDIX

BLUE SKY BELOW MY FEET

APPENDIX

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Characteristics of Youth
9-11 Year Olds

Mental Characteristics	Implications for Blue Sky Project
• Have ability to think logically about "concrete" things, people and activities.	• A concrete operational thinker. Offer critical thinking tasks about what child can see, feel, hear, taste, touch, etc. such as *Topsey Turvey* and *Chewy Leathers* experiments.
• Have desire and ability to separate fantasy from reality.	
• Have increased attention span, although still short compared with adults. Interests change rapidly.	• Offer many different tasks of short duration.
• Have ability to make and carry out short-term plans.	• Plan independent activities and experiments of short duration. Work must be entirely laid out and in small pieces. Outline "things to do" in detail.
• Use accumulated knowledge to solve problems and make judgements.	
• Make insightful analytical judgements of comparative worth of things, people and activities.	
• Have increased interest in the world (sciences and social studies).	• Use experiential curriculum such as Blue Sky. Be prepared for 1001 questions from children.
• Have interest in riddles, jokes, word games, collections, rituals and codes.	
• Have little interest in record keeping.	• Make records simple such as *Search for Space Food* Activity. Provide clear instructions plus supervision.
•Have varied reading abilities.	• Look for reading material that is on appropriate level for child and well-illustrated.

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Physical Characteristics	Implications for Blue Sky Project
• Have slow steady growth. Boys and girls nearly equal in physical, ability and stamina. Greater differences between individuals than between sexes. Pubertal growth spurt near the end of this stage. Growth spurt occurs 1-2 years earlier for girls than boys.	• Plan for a wide variety of differences among participants.
• Have high energy and much activity. Development of muscular strength, agility and coordination.	• Put emphasis on activities that use hands to build, create, cook, etc. Also plan large motor activities such as *Gravity and You* experiments.
• Rapid development of small muscles and maturation of eye function.	•Plan activities requiring eye-hand coordination such as building rocket, computer games, grating vegetables.
Social Characteristics	**Implications for Blue Sky Project**
• Are most comfortable with peers of same sex.	• For partner activities, team up child with child of same sex.
• Like to be a part of group and involved in group activities.	• Use small groups of 2-4 youth without adult and large groups with adult leadership.
• Will have rebellious, or disobedient moments.	• Make known the 'natural consequences' of undesirable behavior rather than threaten with punishment.
• Prejudices can develop based on experience, and peer and adult influence.	• Remind leaders they serve as role models.
• May enjoy both competitive and cooperative activities. Cooperation is more difficult to learn.	• Utilize cooperative teaching strategies such as "peer collaboration".
• Admire and imitate older youth.	• Use teen leaders as role models.

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Emotional Characteristics	Implications for Blue Sky Project
• Have mixed feelings about need for security and need for individuality and independence from parents and others in authority.	• Encourage independence while offering leader supervision and support.
• Have need to know love and acceptance. May have difficulty handling open, direct demonstrations of affection. Will seek approval of leaders and teachers.	• Provide an atmosphere of acceptance. Praise efforts at each level of progress toward a goal. Focus on child's progress rather than an arbitrary standard.
• Anxieties relate to fear of failure or non-acceptance.	• Provide an atmosphere of acceptance.
• Have fears about death, illness, family problems, fire, accidents, etc.	• Be prepared to answer many questions about death of Challenger astronauts.
• Are highly enthusiastic about things or people that are of interest to them. Easily motivated. Eager to try something new.	• Offer variety of activities such as guest speaker from local Air Force base, peer demonstrations, etc.
• Have emerging sense of humor.	• Use wit, word games, practical jokes and funny stories to relieve tension. Encourage same from children.
• May be moody, sulky and uncommunicative on occasion.	• Provide an atmosphere of acceptance.
• Have need for recognition and praise.	• Fire rockets in front of peers, friends and parents.
• Have need for symbols and regalia.	• Provide Blue Sky pins and certificates.

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Blue Sky Below My Feet
Pre/post test or post test only
Oral or written

For the Member

What Did You Learn and Do?

1. Did you build and launch a model rocket? ❑ yes ❑ no

   (a) If yes, describe the flight of your model rocket.

   (b) If yes, what did you learn from building and launching your model rocket?

2. Identify at least 3 important points about gravity.

3. How does gravity affect your daily life? Give examples.

4. Describe how eating on earth is the same as eating in space. How is it different?

5. How are foods prepared to take on the Shuttle?

6. What foods did you prepare for space travel?

7. What kinds of foods (on earth) do astronauts need for strong healthy bodies? Do you need the same or different foods?

8. Name ten foods that are low in fat.

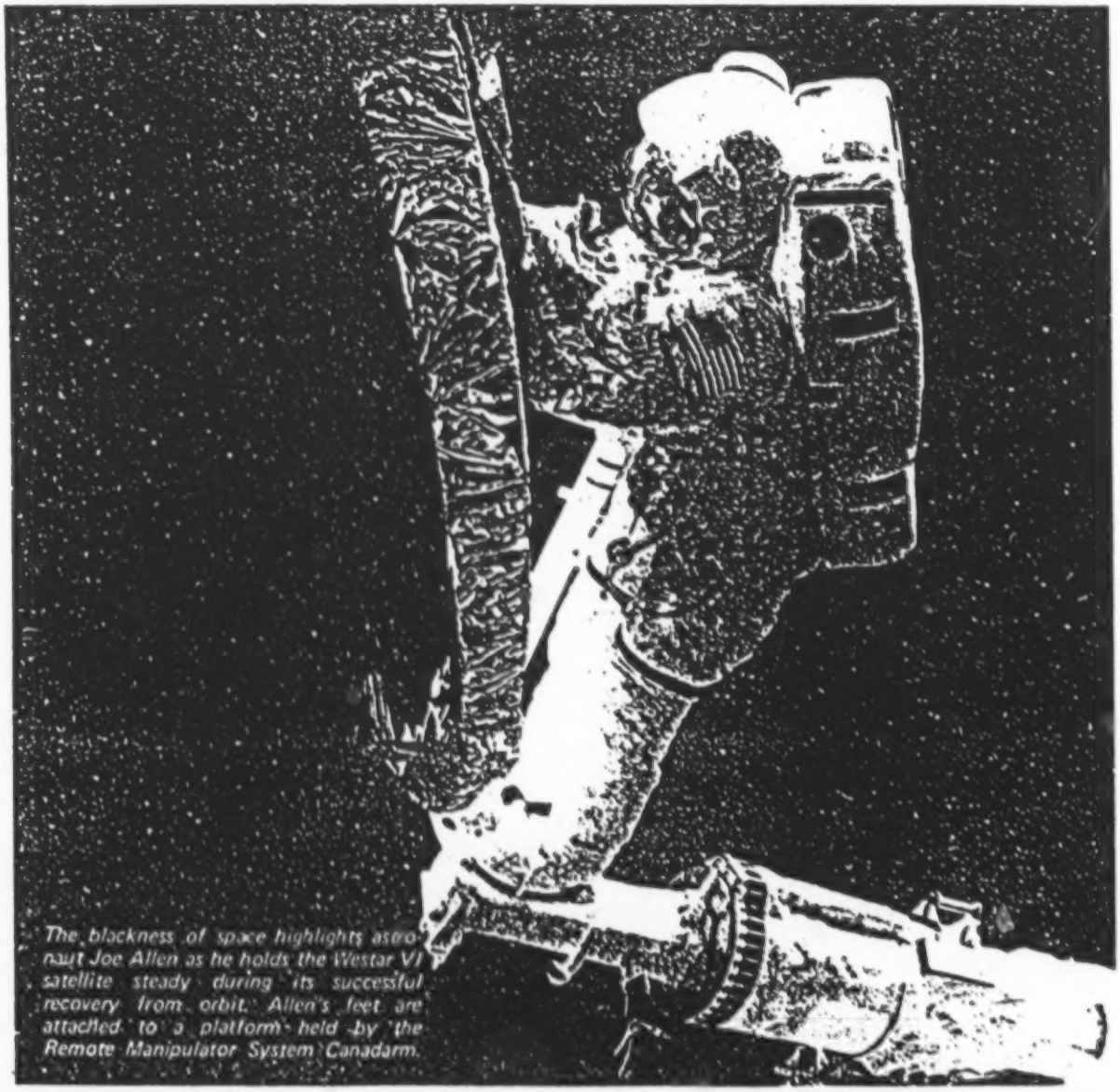
9. Water is an important nutrient. Why is it so special?

NASA
National Aeronautics and
Space Administration

Information Summaries

PMS 017 (KSC)
August 1986

Living and Working on the New Frontier



The blackness of space highlights astronaut Joe Allen as he holds the Westar VI satellite steady during its successful recovery from orbit. Allen's feet are attached to a platform held by the Remote Manipulator System Canadarm.

BEST COPY AVAILABLE

Introduction

The idea that people other than highly trained astronauts would someday live and work in space has long fascinated science fiction fans. Today it interests professional space scientists and engineers as well. The Space Shuttle, in which anyone in ordinary good health can ride into orbit, was the first step in turning this dream into reality. The Space Station, planned for initial operation in the 1993-94 time frame, will provide a permanent facility in orbit for continuing technical and scientific work. It will be operated by rotating crews from Earth, including personnel who are not career astronauts.

Three crews of three astronauts each have lived and worked aboard Skylab, an early type of space station launched in May 1973 and occupied by the final crew until late February 1974. Skylab could not be resupplied with consumables, and was never intended for permanent occupation. But operating it provided valuable data needed by the engineers then planning the human support systems on the Space Shuttle orbiter. That data is still of value to the engineers working on the manned Space Station today.

The Space Shuttle takes much larger crews into orbit than any prior launch vehicle. The work these crews perform varies greatly, according to the particular mission. Some tasks are similar to those done every day on Earth, but most are unique to the requirements of spaceflight. Early missions were devoted primarily to verifying the performance of the Space Shuttle and its associated equipment. Crews on later flights have operated instruments to perform extensive observations of the Earth, studied objects of interest in astronomy, processed materials in microgravity, and performed biological experiments with seeds, plants, insects and small animals. A very important part of the work has been launching satellites for scientific and commercial use, and repairing spacecraft in orbit. Some satellites have been recovered from orbit and returned to the ground, ready to be refurbished and launched again.

The Space Shuttle and Space Station are the largest components in NASA's Space Transportation System, or STS. The system will eventually include other small reusable vehicles and stations as well. The Space Shuttle made 25 flights in its first five years. The Space Station is now in the design phase, and should be operational by 1994. The first of two small reusable support vehicles that will be used in conjunction with the Space Station is also in work.

The Versatile Space Shuttle: Workhorse of the New Frontier

The Space Shuttle is the first reusable aerospace vehicle. It takes off vertically like a rocket. The winged orbiter then maneuvers in orbit like a spaceship. At the end of the mission the orbiter lands on a runway like an unpowered glider. The delta-winged orbiter is about the size and general shape of a DC-9 jetliner.

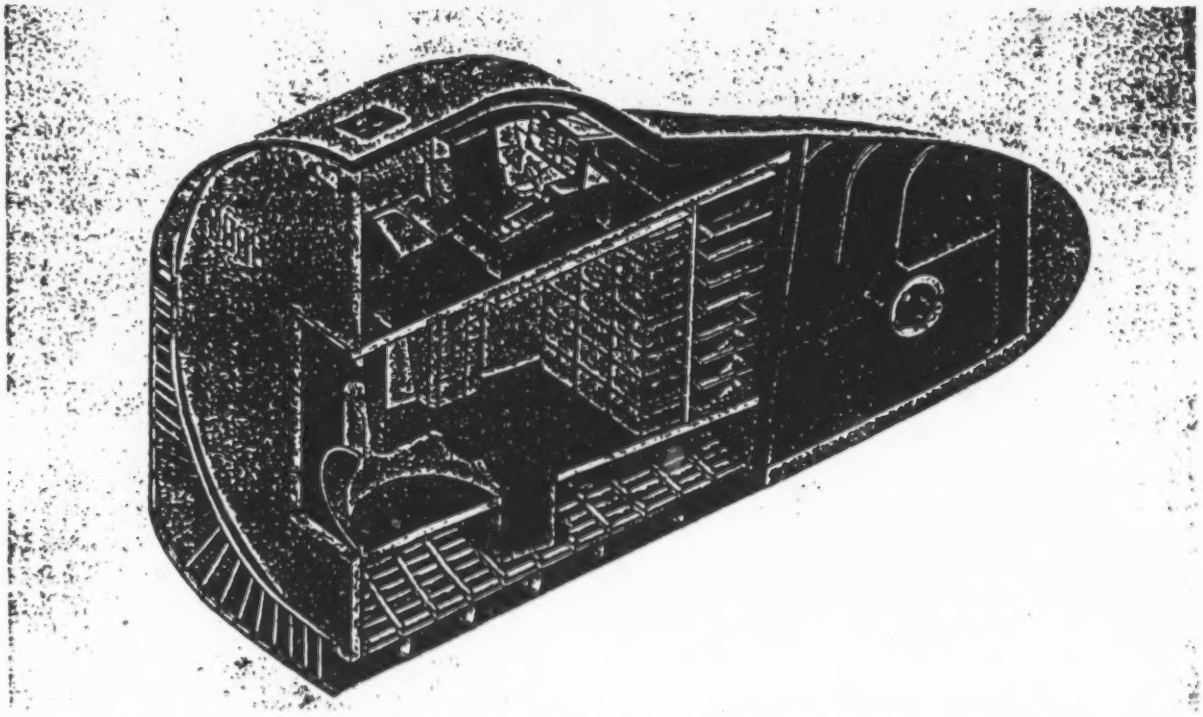
The Shuttle orbiter can be used as an observation platform, from which instruments can be focussed on the ground passing below, or objects of strong interest to astronomers in space. The orbiter can also carry a small but fully equipped manned laboratory, called Spacelab, for medical, scientific, engineering, and industrial experiments. Spacelabs have been flown on four successful missions. The pressurized modules remain in the cargo bay of the orbiter throughout the mission.

One of the key attributes of the Space Shuttle is the relatively low acceleration and deceleration forces exerted on crew and passengers during launch and reentry. These forces reach a peak of 3 G's – three times the force of gravity on the Earth's surface – for a few minutes at a time. The strain is well within the limits which can be tolerated by healthy people.

The Orbiter Crew Compartment

The living space aboard an orbiter is relatively roomy and comfortable, compared to that in earlier manned spacecraft. There are two floors in the pressurized cabin located in the nose section (see illustration). Together they provide 71.5 cubic meters (2,525 cubic feet) of space. The temperature can be regulated to stay between 16 and 32 degrees Celsius (61 and 90 degrees Fahrenheit).

The top level of the cabin is the flight deck. Here the commander and pilot monitor and operate a sophisticated array of controls that are far more complicated than those of a giant jetliner. Behind their seats is a work area for mission and payload specialists. There crewmembers operate experiment controls, and check out and deploy spacecraft carried inside the large, unpressurized cargo bay. The bottom level of the cabin is the mid deck. This is the living quarters for the crew, although experiments that require air, such as plants and small animals, can also be carried here. The mid deck contains lockers for stowing crew equipment, and facilities for sleeping, eating, personal hygiene, and waste disposal.



The orbiter's two-story crew cabin contains a flight deck on the top level and living quarters underneath. This cut-a-way view shows the left side of both stories.

Air pressure inside the crew compartment is the same as Earth's at sea level: 1,033 grams per square centimeter (14.7 pounds per square inch). This atmosphere is made up of 80 percent nitrogen and 20 percent oxygen. Earth's atmosphere is 78 percent nitrogen, 21 percent oxygen, and one percent other gases, such as argon and neon. The crew members wear ordinary clothing. They don the bulky spacesuits only for extravehicular activities outside the cabin.

Fans circulate the cabin air through cleansing filters, which are changed regularly. These filters contain activated charcoal to remove odor, and lithium hydroxide to remove carbon dioxide. Excess moisture is also removed, keeping the humidity at comfortable levels. The air in an orbiter is cleaner than that on Earth. Hay fever sufferers would welcome such a pollen-free atmosphere.

What Space Travelers Eat

The one, two, and three-person crews in earlier programs ate their meals out of containers or pouches, most commonly prepared by adding water and kneading the mixture by hand. The food was nutritious, but not very appetizing. The Space Shuttle carried eight people on one mission, and seven has been a common number. For these large crews, or missions planned to last for a week or more, a galley "mission kit" can be loaded in the orbiter mid deck.

The mid deck galley includes special serving trays that hold the different food containers in place in microgravity. It also has a convection-type oven where packages of food are warmed before going into the trays. A small dining area, consisting of a table and several foot loops, is optional on each mission. The foot loops are floor restraints that help the astronauts steady themselves and remain in place while eating.

If no galley is loaded aboard, the astronauts eat virtually the same meals, but they are heated inside a food warmer the size of a suitcase. Earth-bound chefs might envy meal preparation on the orbiter. One crew member can prepare meals for four people in about five minutes (excluding heating time).

The orbiter does not normally carry a refrigerator because of the weight. If one is needed for biomedical experiments, and extra room is available, foods such as ice cream and frozen steaks may be added to the astronaut menu.

About half the Shuttle foods and beverages are preserved by dehydration, which saves both weight and storage space. There is ample water for rehydration, since the fuel cells that power the orbiter produce it as a byproduct when generating electricity. (Both hot and cool water are available.) Some foods are thermostabilized – that is, heat-sterilized and then sealed in conventional cans or plastic pouches. A few, such as cookies and nuts, are available in a ready-to-eat form.

Meals in orbit are both tasty and nutritious. The menu includes more than 70 food items and 20 beverages. With so many different choices available, astronaut crews can have a varied menu every day for four days.

What are these meals in space like? The menu for a typical day might start with orange drink, peaches, scrambled eggs, sausage, cocoa and a sweet roll for breakfast; cream of mushroom soup, ham and cheese sandwich, stewed tomatoes, banana and cookies for launch; and shrimp cocktail, beefsteak, broccoli au gratin, strawberries, pudding and cocoa for dinner.

The carefully selected menus provide about 3,000 calories per person daily, although crew members are not required to eat that much. Previous space missions demonstrated that astronauts need at least as many calories in space as they do on Earth.

Meals served on the Space Station, at least at the beginning, will resemble those available on the Space Shuttle. Later, perhaps small vegetable gardens will supply fresh produce, as well as absorb carbon dioxide from the atmosphere while supplying oxygen for the crew.

Sanitation in Orbit

Sanitation is more important within the confines of a spacehship or space station than on Earth. Studies have shown that the population of some microbes can increase extraordinarily in microgravity and confined spaces. This means many infectious illnesses could easily spread to everyone aboard.

The eating equipment, dining area, toilet, and sleeping facilities in an orbiter are regularly cleaned, to prevent the growth of microorganisms. Since there is no washing machine aboard, trousers (changed weekly), socks, shirts, and underwear (changed every two days) are sealed in air tight plastic bags after being worn. Garbage and trash are also sealed in plastic bags.

Shuttle travelers don't have to do many dishes. Food containers go into the plastic bags, and eating utensils and trays are cleaned with wet wipes.

A favorite early question of people interested in space was how the astronauts took care of digestive elimination. The orbiter travelers use a toilet that operates very much like one on Earth. A steady flow of air moves through the unit when it is in use, carrying wastes to a special container or into plastic bags. The container can be opened to vacuum, which exhaust the water and dries the solids, and the plastic bags, when used, can be sealed.

Some of the wastes may be returned to Earth for postflight laboratory analysis. In the past, such analyses have helped doctors understand how the body functions in microgravity, including data on which minerals the body loses in unusual amounts.

Astronaut Rhea Seddon, right, tests a Shuttle hand washer under zero-gravity conditions. An airflow causes water to rush across the hands, like water flowing from a tap, then out of the device and into waste water storage tanks.

Astronaut John Young shaves in the mid deck area on the STS-1 mission. To the right of his hand is a tray with several items of food, attached vertically to a compartment door.

Unlike Skylab, which had an enclosed shower, Shuttle travelers can only take sponge baths in space. Water droplets float about in weightlessness, creating a potential hazard for electrical equipment. Water is obtained from a handgun, where the temperature can be set at any comfortable level from 18 to 35 degrees C (65 to 95 degrees F). Dirty water from the sponge is squeezed into an airflow system which conveys it to the orbiter's waste collection tank.

Whiskers cut off in shaving could also become a nuisance if they float about, with a potential to damage equipment. Male astronauts can avoid this problem by using conventional shaving cream and a safety razor, then cleaning off the face with a disposable towel.

The sleeping and sanitary arrangements for the Space Station are still in the design stage. Engineers are drawing on the experience gained in earlier manned space flight programs to plan systems that will be more like those on Earth. Eventually, a visitor to the Space Station should be able to eat a meal or use the sanitary facilities without special instructions.

Spacesuits and Rescue Equipment

In earlier programs spacesuits were tailor-made for each astronaut, a time-consuming and expensive process. Now only the gloves are custom-fitted. The Shuttle spacesuit is made in small, medium, and large sizes, and can be worn by either men or women. The suit comes with an upper and lower torso, equivalent to a shirt and trousers, and the two pieces snap together with seal rings. A life support system comes built into the upper torso. All earlier versions had separate support systems that had to be connected to the suits.

Space-suited astronaut Bruce McCandless goes through a training exercise with a personal rescue enclosure.

The Shuttle spacesuit is lighter, more durable, and easier to move about in than its predecessors. It is only used for an extravehicular activity (EVA) outside the crew cabin. The astronauts wore pressure suits, of the kind worn by military jet pilots, during early test flights. Now they wear regular clothing.

Only two spacesuits are normally carried on a flight. If a transfer from one vehicle to another should be necessary in the future, personal rescue enclosures are available for the remaining crew members. These are 83.36 centimeter (34-inch) diameter (when pressurized) spheres, each containing life support and communications gear.

In an emergency in space that required abandoning the orbiter, two astronauts would don the spacesuits and, if needed, the Manned Maneuvering Units (MMUs). The latter have built-in propulsion systems. The rest would enter the personal rescue enclosures. The two suited astronauts would transfer their crewmates to the rescue ship. This could be accomplished by rigging a pulley and clothesline device between the two vessels, using the Canadarm Remote Manipulator System, or physically towing the enclosures through space with the power of the MMUs.

Recreation and Sleeping

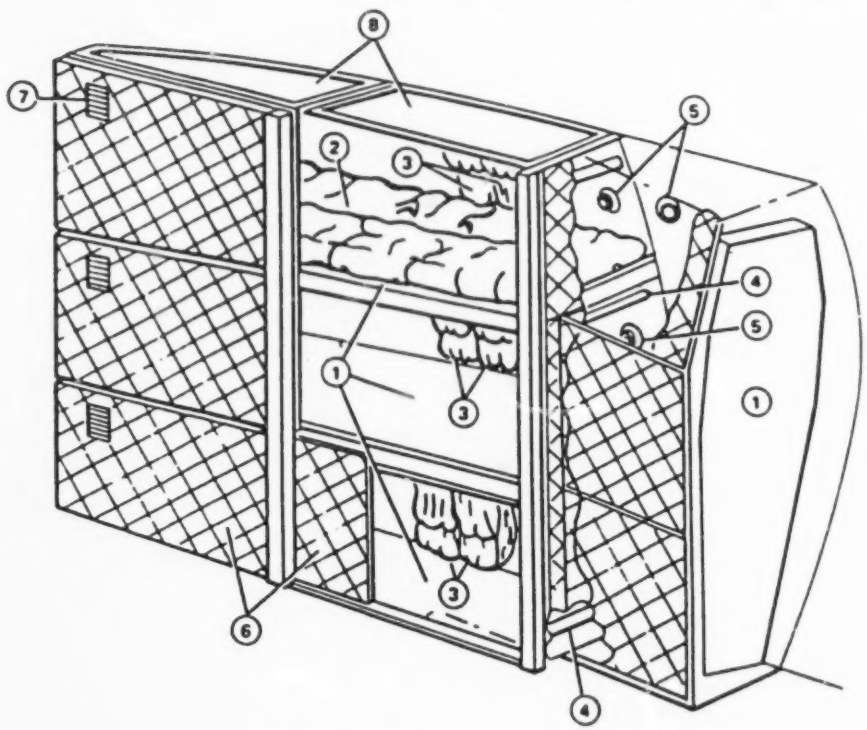
Just as on Earth, recreation and sleep are important to good health when working in space. Astronauts perform a scientifically planned exercise program, largely to counter the atrophy some muscles experience in a weightless environment. Cards and other games, books, and taped music can be taken aboard. Tape recorders are available.

Sleeping accommodations aboard the Shuttle vary, depending on the requirements of the particular mission. On the first flight, astronauts Young and Crippen slept in the commander and pilot seats. They wanted to be instantly available if needed. Later crews slept in their seats, in sleeping bags, in bunks, or by simply tethering themselves to the orbiter walls.

The sleeping bags are cocoon-like restraints attached to the lockers where crew provisions are stored. In microgravity there is no 'up,' and the astronauts can sleep as comfortably in the vertical position as the horizontal.

A bunkbed kit (see illustration) was available by the time of the STS-9 mission. Crew members could sleep in three horizontal bunks when these were installed, and an extra vertical bunk was

The Shuttle orbiter can be outfitted with up to four bunks, three horizontal and one vertical.



1. SLEEP PALLET
2. SLEEP RESTRAINT
3. PERSONAL STOWAGE
4. LIGHT
5. VENTILATION INLET
6. REMOVABLE PANELS AND SUPPORTS FOR ACCESS TO UNDER-FLOOR STOWAGE
7. VENTILATION OUTLET AT FOOT END, ALL STATIONS
8. OVERHEAD LIGHT SHIELDS

Astronaut Sally Ride catches forty winks in the warmth and comfort of an anchored sleeping bag during the STS-7 mission.

available if needed. Each bunk comes complete with an individual light, communications station, fan, sound suppression blanket, and sheets with microgravity restraints. The bunks even have pillows.

When the bunks must be removed to allow room in the mid deck for experiments or extra equipment, up to four optional sleeping bags can be used instead.

The Continuing Challenge of Microgravity

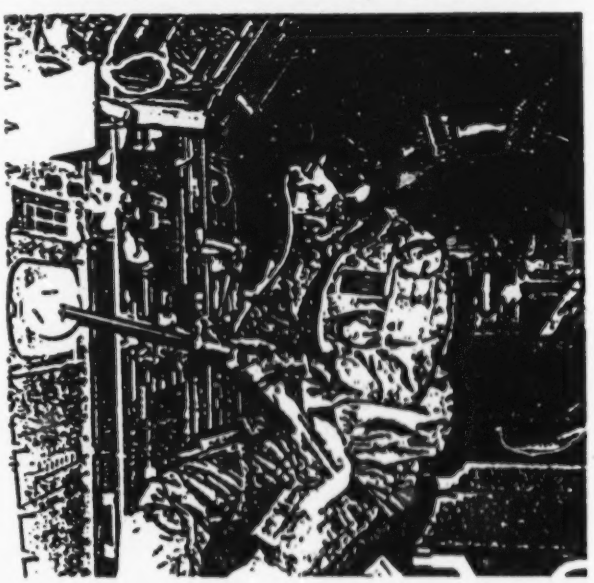
Many of the problems that arise from living and working in space have been resolved. However, the physiological affects of weightlessness are still not completely understood. Among these are the leaching of certain minerals from bones; atrophy of muscles when not exercised; and space adaptation syndrome, a form of motion sickness found only in spaceflight.

All the deleterious effects of living in microgravity disappear after an astronaut returns to the ground. Some can be countered while in orbit by special diet and exercise. But even a vigorous exercise program does not appear to stop bone loss, or the decrease in the rate of normal bone formation. NASA is engaged in a longterm program to understand the causes underlying these changes, in order to develop ways to prevent them. This will be particularly important for the longer tours of duty on the Space Station, where crew members will be in orbit for three months or more at a time.

The Future. Living and Working Aboard a Permanent Space Station

The Space Station NASA is now planning and designing is a large facility. It will be resupplyable and capable of staying in orbit indefinitely, unlike Skylab. Many of its systems will be highly automated, leaving the crew more time for the tasks that can only be performed by humans. Present plans call for the initial configuration to be in operation by the end of 1994.

The Space Station will be a permanent, multi-purpose facility operating in orbit. It will serve as a laboratory, to conduct long-term basic research in the almost perfect vacuum and microgravity of space; a manufacturing plant, to make exotic metal alloys, super-pure pharmaceuticals, or perfect crystals; a spacecraft garage and repair facility; and a base for the assembly in orbit of other large structures. It will also support nearby free-flying Earth observation, astronomy, and materials processing platforms, among many other applications. There will be a tremendous amount and variety of work to do.

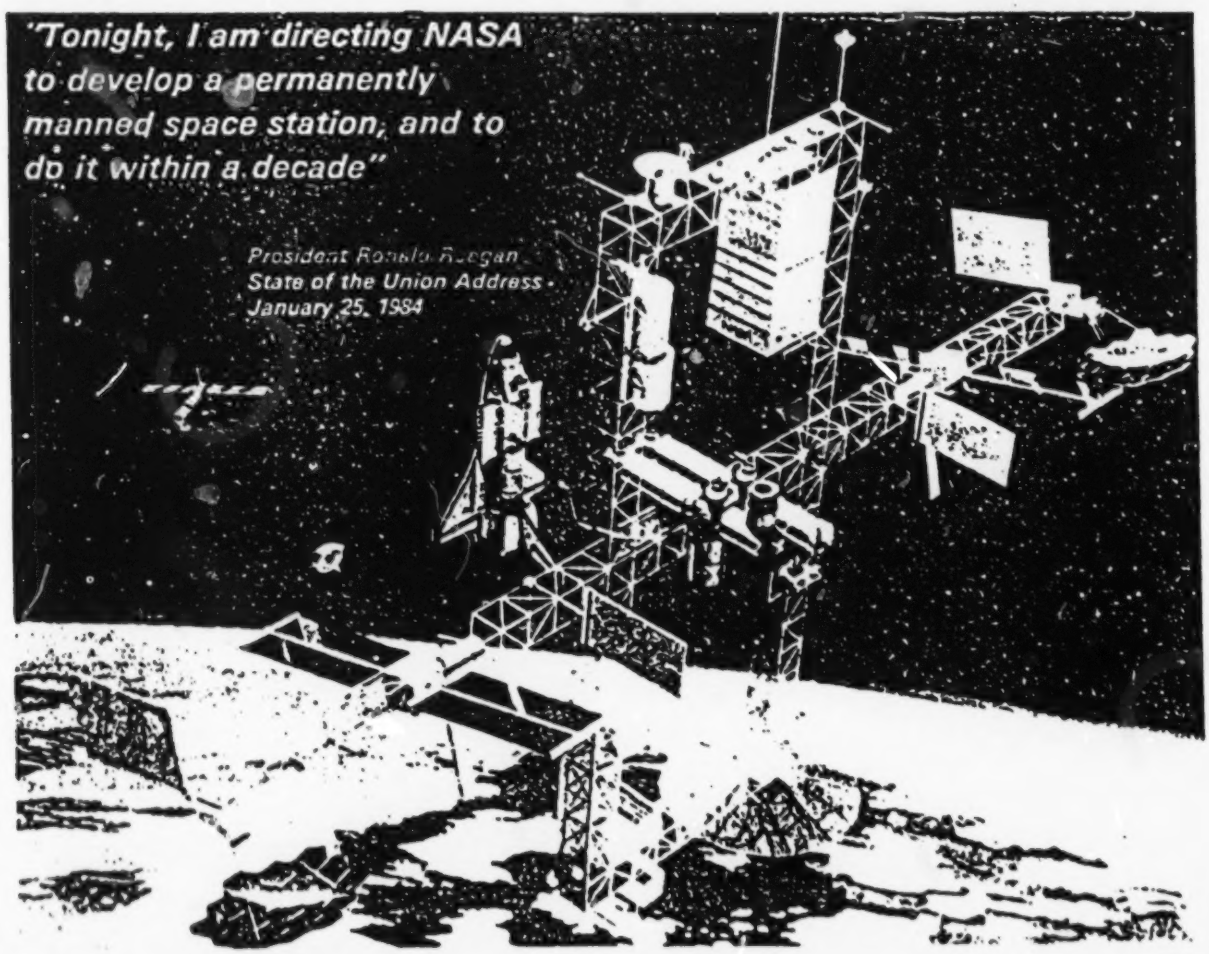


Ulf Merbold, a citizen of West Germany working for the European Space Agency, performs a materials science experiment during the first Spacelab flight.

Initial plans call for a crew of six to eight people in the operational Space Station, supported by resupply and crew rotation flights of the Space Shuttle every three months. One major advance planned for the Space Station is a closed-cycle environmental control and life support system. The oxygen will be recovered from the carbon dioxide exhaled by the crew, and the wash water, urine, and condensate will be purified and reused. Present planning calls for only food and nitrogen to be periodically resupplied from Earth.

The Space Station dual keel is 90.5 meters (297 feet) in length, with an even longer single strut across it that supports the solar cell arrays. Overall, it is larger than a football field. The crew will operate and live primarily in four or more pressurized modules, located near the center of the structure. The standard module will be 13.3 meters (43.7 feet) long and approximately 4.5 meters (15 feet) in diameter. They will be connected by tunnels and various support structures. The Space Station will provide far more working and living room than any earlier facility designed to operate in space.

Several other nations and space organizations are working cooperatively with NASA to design and build some components of the Space Station. They too will have personnel living and working aboard. The Space Station has been called "the next logical step" in the continuing exploration and utilization of space, the new frontier mankind has only started to explore. Improving the living and working conditions of the people involved is an important part of the total effort.


"Tonight, I am directing NASA to develop a permanently manned space station, and to do it within a decade"
President Ronald Reagan
State of the Union Address
January 25, 1984

The Space Station, larger overall than a football field, will be the first permanent, resupplyable facility operated in orbit by the United States.

NASA Facts

National Aeronautics and
Space Administration
NF-150/1-86

Space Shuttle Food Systems

Astronaut Joe Allen (on STS-5) forces orange drink out of a beverage container through the straw. Liquids form spherical shapes when they are allowed to float freely in space.

Space Shuttle Food Systems

By Robert Haynes

Imagine it's the year 2000 and you are visiting a friend who lives and works in an orbiting community high above the planet. You are seated with a seatbelt strapped across you, and are leaning back for lift off. The launch is invigorating and now you relax in orbit while the spacecraft heads to its rendezvous with the community in space. It will be awhile before the spaceship docks at the spaceport, so the cabin attendant begins to prepare dinner. The attendant leans over to you and says, "Today's specials are New York strip steak with mushroom sauce and baked turkey with dressing." You decide, however, on the weight-watchers' platter, and the attendant smiles.

Sound farfetched? It's not. By the year 2000, the Space Station will have been operating for several years, and the Space Shuttle will have been the platform from which it was built, as well as the airline that transported workers and residents to it. The Shuttle already makes regular trips to the near-weightless environment of Earth orbit on missions of both scientific and commercial benefit. On every mission, astronauts eat healthy, well-balanced, and good-tasting meals.

The kinds of foods the Space Shuttle astronauts eat are not mysterious concoctions, but foods prepared here on Earth, many commercially available on grocery store shelves. Diets are designed to supply each Shuttle crew member with all the Recommended Dietary Allowances (RDA) of vitamins and minerals necessary to perform in the environment of space.

In fact, astronauts have an astonishing array of food items. They may eat from a standard menu designed around a typical Shuttle mission of 7 days, or may substitute items to accommodate their own tastes. Astronauts may even design their own menus. But those menus designed by astronauts themselves must be checked by a dietician to insure the foods supply the astronauts with a balanced supply of nutrients.

The standard Shuttle menu repeats after 7 days. It supplies each crew member with three balanced meals, providing 2800 Kilocalories each day. Each astronaut's food is stored aboard the Shuttle and identified by a colored dot affixed to each package.

The Shuttle Food System

On the Space Shuttle, food is prepared at a galley installed on the Orbiter's mid-deck. The galley is a modular unit that can be removed for special weight-critical missions or missions that require extra interior space. It contains a personal hygiene station, a water dispenser, an oven, condiment and meal tray stowage, and a food preparation area.

The personal hygiene station lets crew members wash their hands and small items, and sponge bathe in zero gravity without allowing water to escape into the spacecraft's atmosphere. The water dispenser is used for rehydrating foods, and the galley oven is for warming foods inside their square packages and foil pouches.

The galley doors are lined with Velcro strips. Metal meal trays for each crew member are also lined with Velcro strips and can be attached to the galley doors to provide meal assembly areas in the galley.

On Shuttle missions that require every gram and centimeter to be occupied by payload, a portable, suitcase-type food and beverage warmer is on board. To rehydrate foods, an Orbiter Water Dispensing Assembly (OWDA) is mounted on the mid-deck wall and operates almost like the galley water dispenser. However, the OWDA does not have hot water, only cold and ambient water.

Almost Like Eating At Home

During a typical meal in space, food is held in a meal tray inside its containers. The tray can be either attached to an astronaut's lap by a strap or attached to a wall. The meal tray becomes the astronaut's dinner plate and enables him or her to choose from several foods at once, just like a meal at home. But without the tray, the contents of one container must be completely consumed before opening another. The tray also holds the food packages in place and keeps them from floating away in the microgravity of space.

Eating utensils in space are also conventional. Astronauts use knife, fork, and spoon. The only unusual eating utensil is a pair of scissors used for cutting open packages. Following the meal, food containers are discarded in the trash compartment below the mid-deck floor. Eating utensils and food trays are cleaned at the hygiene station with premoistened towelettes.

Crews have reported that the Shuttle food system functions well in space. It consists of familiar, appetizing, well-accepted food items that can be prepared quickly and easily. A full meal for a crew of four can be set up in about 5 minutes. Reconstituting and heating the food takes an additional 20 to 30 minutes—about the time it takes to fix a snack at home, and far less than it takes to cook a complete meal.

Pantry

A supplementary food supply that provides approximately 2100 Kilocalories per person for two extra days is stowed aboard the Shuttle for each flight. Pantry items are flown in addition to the menu, in case the flight is unex-

pectedly extended because of bad weather at the landing site or some other unforeseen reason. During the flight, this food supply provides extra beverages and snacks. The pantry items can also be exchanged for menu items in flight, but all unused food packages are retained in the pantry so they will be available in case they are needed later.

But It Wasn't Always This Easy

The food that NASA's early astronauts had to eat in space is a testament to their fortitude. John Glenn, America's first man to eat anything in the near-weightless environment of Earth orbit, found the task of eating fairly easy, but found the menu not very tasty. Other Mercury astronauts had to endure bite-sized cubes, freeze-dried powders, and semi-liquids stuffed in aluminum tubes. Most agreed the foods were unappetizing and disliked squeezing the tubes. Moreover, freeze-dried foods were hard to rehydrate and crumbs had to be prevented from fouling instruments.

The astronauts complained and on the Gemini missions eating improved somewhat. The first things to go were the squeeze tubes. Bite-sized cubes were coated with gelatin to reduce crumbling, and the freeze-dried foods were encased in a special plastic container to make reconstituting easier. With improved packaging came improved food quality and menus. Gemini astronauts had such food choices as shrimp cocktail, chicken and vegetables, butterscotch pudding, and apple sauce, and were able to select meal combinations themselves.

By the time of the Apollo program, the quality and variety of food increased even further. Apollo astronauts were first to have hot water, which made rehydrating foods easier and improved the food's taste. These astronauts were also the first to use the "spoon bowl," a type of pressurized, plastic container that could be opened and its contents eaten with a spoon.

The task of eating in space got a big boost in Skylab. Unlike previous space vehicles for astronauts, Skylab featured a large interior area where space was available for a dining room and table. Eating for Skylab's three-member teams was a fairly normal operation: footholds allowed them to situate themselves around the table and "sit" to eat. Added to the conventional knife, fork, and spoon was a pair of scissors for cutting open plastic seals. Because Skylab was relatively large and had ample storage area, it could feature an extensive menu: 72 different food items. It also had a freezer and refrigerator, a convenience no other vehicle offered.

Freeze-drying Process. *When foods are to be freeze dried they are first prepared as if ready to eat. Then they are quickly frozen. The frozen product is placed in a commercial freeze-dehydration unit and subjected to a vacuum in the closed chamber. The frozen food is placed in the vacuum chamber on shelves that can be heated. While under vacuum, heat is slowly applied to the frozen product. This heat, which is kept low enough so the product does not melt, causes sublimation of the ice in the product. In this way the moisture in the food is vaporized and condensed on cold plates at the bottom and along the sides of the vacuum chamber. The final freeze-dried product retains its original shape but it is much lighter without its water content. This method of freeze drying foods makes them easier to reconstitute than in most other methods.*

SPACE SHUTTLE MENU DESIGN

The Shuttle menu is designed to provide nutrition and energy requirements essential for good health and effective performance with safe, highly acceptable foods. In order to maintain good nutrition, the menu provides the Recommended Dietary Allowances as follows:

Protein	(g)	56	Vitamin B_{12}	(g)	3.0
Vitamin A	(iu)	5000	Calcium	(mg)	800
Vitamin D	(iu)	400	Phosphorous	(mg)	800
Vitamin E	(iu)	15	Iodine	(μg)	130
Ascorbic Acid	(mg)	45	Iron	(mg)	18
Folacin	(μg)	400	Magnesium	(mg)	350
Niacin	(mg)	18	Zinc	(mg)	15
Riboflavin	(mg)	1.6	Potassium	(meq)	70
Thiamine	(mg)	1.4	Sodium	(meq)	150
Vitamin B_6	(mg)	2.0			

Types of Foods. *Weight and volume have always been primary design factors for every piece of hardware launched into space. The Shuttle is no exception. Weight allowed for food is limited to 3.4 pounds per person per day, which includes the 1 pound of packaging for each person each day. Although there is currently no room on board the Shuttle for a freezer and refrigerator, designs are underway to build them.*

Foods are individually packaged and stowed for easy handling in the zero gravity of space. All food is precooked or processed so it requires no refrigeration and is either ready to eat or can be prepared simply by adding water or by heating. The only exceptions are the fresh fruit and vegetables stowed in the fresh food locker. Without refrigeration, the carrots and celery must be eaten within the first two or three days of the flight or they will spoil.

Rehydratable (R) Food and Beverages (B)

Rehydratable items include both foods and beverages. One way weight can be conserved in the food system is to remove water for launch. During the flight, water is added back to the food just before it is eaten. The Shuttle Orbiter fuel cells, which produce electricity by combining hydrogen and oxygen, provide ample water for rehydrating foods as well as drinking and a host of other uses.

Foods packaged in rehydratable containers include soups like chicken consomme and cream of musbroom, casseroles like chili macaroni and chicken

rice, appetizers like shrimp cocktail, and breakfast foods like scrambled eggs and cereals. Breakfast cereals are prepared by packaging the cereal in a rehydratable package with nonfat dry milk and sugar, if needed. Water is added to the package just before the cereal is eaten.

So far, all vegetables on the Shuttle are freeze dried, but the only freeze-dried fruits are strawberries and peach ambrosia. Blueberries are included in one granola item.

Rehydratable Package

Rehydratable food and beverages are packaged in square, nestable containers designed especially to maximize Shuttle storage space and to minimize package cost. Individual packages have a rigid, opaque base that serves as a bowl and have a flexible, see-through film lid. The lid, which allows visibility while mixing food with water, is heat-sealed to the base.

Water is introduced into the package (without breaking the seal) through a hollow needle inserted through a septum in the base of the cup. After the cup is completely rehydrated, it may be heated. At mealtime, the astronaut removes the package lid with a knife or scissors and food is consumed directly from the container with conventional eating utensils. Beverages are consumed by inserting a polyethylene straw into the package through the septum after the beverage is rehydrated. A clamp on the straw prevents the fluid from flowing out of the package in zero gravity.

Thermostabilized (T) Food

Thermostabilized foods are heat processed to destroy deleterious microorganisms and enzymes. Individual servings of these thermostabilized foods are commercially available in aluminum or bimetallic cans or in flexible retort pouches. The cans open with either easy-open, full-panel pull-out lids or can openers. Most of the fruits, all of the puddings, and fish such as tuna and salmon are thermostabilized in cans. Most of the entrees are packaged in flexible retort pouches. This includes products such as beef and gravy, sliced beef with barbecue sauce, chicken ala king, and ham. After the pouches are heated, they are cut open with scissors. The food is eaten directly from the containers with conventional eating utensils.

Intermediate Moisture (IM) Foods

Intermediate moisture foods are preserved by restricting the amount of water available for microbial growth, while retaining sufficient water to give the food a soft texture and let it be eaten without further preparation. Water is removed or its activity restricted with a water-binding substance such as sugar or salt. Intermediate moisture foods usually range from 15 to 30 percent moisture, but the water present is chemically bound with the sugar or salt and is not available to support microbial growth. Dried peaches, pears, and apricots, and dried beef are examples of this type of Shuttle food.

Natural Form (NF) Foods

Foods such as nuts, granola bars, and cookies are classified as natural form foods. They are ready to eat, packaged in flexible pouches and require no further processing for consumption in flight. Both natural form and intermediate moisture foods are packaged in clear, flexible pouches that are cut open with scissors.

Irradiated (I) Meat

Beef steak and smoked turkey are the only irradiated products currently used on Shuttle. They are cooked, packaged in flexible, foil-laminated pouches, and sterilized by exposure to ionizing radiation so they are stable at ambient temperature.

Condiments

Condiments include commercially packaged individual pouches of catsup, mustard, mayonnaise, taco sauce, and hot pepper sauce. Polyethylene dropper bottles contain bulk supplies of liquid pepper and liquid salt. The pepper is suspended in oil and the salt is dissolved in water.

Shuttle Standard Menu After STS-9

Meal			
A	Dried pears (IM) Sausage patty (R) Scrambled eggs (R) Cornflakes (R) Cocoa (B) Orange pineapple drink (B)	Dried peaches (IM) Granola (R) Breakfast roll (NF) Vanilla instant breakfast (B) Orange grapefruit drink (B)	Dried apricots (IM) Seasoned scrambled eggs (R) Bran flakes (R) Cocoa (B) Orange juice mix (B)
B	Ham (T) Bread (NF) Diced peaches (T) Pecan cookies (NF) Apple drink (B)	Salmon (T) Bread (NF) Diced pears (T) Butter cookies (NF) Lemonade (B)	Peanut butter (T) Jelly (T) Bread (NF) Fruit cocktail (T) Tea w/lemon and sugar (B)
C	Chicken ala king (T) Chicken and rice (R) Asparagus (R) Chocolate pudding (T) Grape drink (B)	Beef w/BBQ sauce (T) Potatoes au gratin (R) Green beans w/mushrooms (R) Butterscotch pudding (T) Orange drink (B)	Frankfurters (T) Potato patty (R) Green beans and broccoli (R) Strawberries (R) Vanilla pudding (T) Tropical punch (B)

Meal			
A	Dried pears (IM) Beef patty (R) Breakfast roll (NF) Grapefruit drink (B)	Dried peaches (IM) Sausage patty (R) Mexican scrambled eggs (R) Granola w/raisins (R) Cocoa (B) Orange pineapple drink (B)	Dried apricots (IM) Beef patty (R) Seasoned scrambled eggs (R) Chocolate instant brkfst (B) Orange grapefruit drink (B)
B	Ham (T) Cheese spread (T) Bread (NF) Pineapple (T) Cashews (NF) Strawberry drink (B)	Dried beef (NF) Bread (NF) Applesauce (T) Peanuts (NF) Tea w/lemon and sugar (B)	Tuna (T) Bread (NF) Lemon pudding (T) Shortbread cookies (NF) Almonds (NF) Apple drink (B)
C	Meatballs w/BBQ (T) Rice pilaf (R) Italian vegetables (R) Chocolate pudding (T) Apple drink (B)	Turkey and gravy (T) Turkey tetrazzini (R) Cauliflower w/cheese (R) Brownies (NF) Lemonade (B)	Ground beef w/spice sauce (T) Potato patty (R) Broccoli au gratin (R) Diced pears (T) Orange drink (B)

Meal	
A	Dried peaches (IM) Beef patty (R) Mexican scrambled eggs (R) Granola w/blueberries (R) Orange juice mix (B)
B	Chicken salad spread (T) Bread (NF) Vanilla pudding (T) Chocolate covered cookies (NF) Lemonade (B)
C	Shrimp cocktail (R) Beef and gravy (T) Macaroni and cheese (R) Green beans w/mushrooms (R) Peach ambrosia (R)

Abbreviations

T *Thermostabilized*
IM *Intermediate Moisture*
R *Rehydratable*
NF *Natural Form*
B *Beverage (Rehydratable)*

From 4-H Leader/Teacher Handbook for ***BLUE SKY BELOW MY FEET,*** Adventures in Space Technology, pages 12 - 16 and pages 21 - 25.

Basic Information on the Space Shuttle

Originally conceived in the late 1960's, a Space Shuttle is an aircraft designed to carry astronauts into outer space to conduct research and to explore space. Three Shuttle vehicles are in operation: "Columbia," "Discovery" and "Atlantis." Each is designed to be reused more than 100 times, and technicians can prepare them for new flights within weeks after a mission. A typical mission lasts from three to six days and covers approximately 40,000 miles per day. In a typical orbit, the Shuttle operates about 175 miles above Earth, at an orbiting speed of five miles per second or 17,500 MPH. In its 90-minute Earth orbit, crew members experience near-zero gravity or weightlessness.

Weighing more than 150,000 pounds and controlled by a maximum crew of nine, a Shuttle is designed to carry up to 65,000 pounds of payload into space. This payload can be experimental equipment or satellites of all kinds.

The crew of the Shuttle can place satellites in orbit and retrieve them for repair either in space or upon return to Earth. Specially-designed space suits and powered maneuvering units (MMUs) permit the astronauts to move about and work untethered for about six hours in space outside the Shuttle. A variety of experiments can be performed by crew scientists aboard the Space Shuttle.

The Shuttle can also carry into orbit experimental space laboratories such as "Spacelab" or large solar power stations for future use. A number of operations in the payload bay are conducted using a 50-foot manipulator arm directed from within the Shuttle.

The Shuttle is moved three miles to the launch pad on a gravel road 130 feet wide by a six-million-pound crawler transporter. The Space Shuttle is in three main parts: the Shuttle or orbiter, the external liquid fuel tank, and two solid rocket boosters.

The orbiter is 121 feet long, has a 79-foot wingspan, and weighs about 150,000 pounds without fuel (200,000 with payload). It's about the size of a DC-9 airplane, with a payload bay 60 feet by 15.

The Shuttle is propelled into space by three main liquid engines (fed supercooled oxygen and hydrogen from the 500,000-gallon fuel tank) and by two 150-foot-high solid-fuel rocket boosters, the largest ever flown. Each contains more than one million pounds of propellant. The liquid fuel tank is the only part of the Shuttle that isn't reusable. It drops off and burns up in the atmosphere. The solid rocket boosters burn for about two minutes with five million pounds of thrust before being jettisoned and

parachuted into the ocean for reuse. The main Shuttle engines burn for about eight minutes generating more than one million pounds of thrust before shutting down. Engine exhaust approaches 6000°F. The Shuttle takes off like a rocket, maneuvers in Earth orbit like a spacecraft, and lands like a glider at about 200 MPH.

The Shuttle is an amazing craft. In addition to the three main engines and the two booster rockets, the Shuttle has 46 other maneuvering engines. Teams of engineers and designers also had to design power generators, hydraulic systems, environmental controls and waste disposals into the Shuttle to provide operations, control and life support systems for the astronauts. Compact food preparation and sleeping accommodations are included. More than 2,020 separate displays and controls are located on the flight deck.

A set of extremely complex computer guidance, monitoring and control systems protects and guides the Shuttle, and a world-wide communications system with hundreds of computers provides two-way Shuttle and crew-to-Earth communications. Special NASA ships are contacted to retrieve the reusable rocket boosters from the ocean.

Thermal protection is given the Shuttle during entry to and from Earth to protect it from surface temperatures of up to 3600°F. The most notable feature of this protection is a set of 20,000 heat-absorbent tiles on the lower surface of the Shuttle. Another 7,000 tiles are located on the upper wing and fuselage. Together, protective tiles cover approximately 70 percent of the Shuttle's surface.

Launch, back-up, support, control and retrieval facilities are located mainly at the Johnson Space Center (Houston, TX), Cape Kennedy (FL), and Edwards Air Force Base (CA).

Basic Information on Gravity and Forces

Gravity is a force that has always affected humans. It works for you and against you. But it was only some 300 years ago that the Englishman, Isaac Newton, discovered the principles of gravity.

What are three of these principles? One is that every particle, no matter how small, attracts every other particle. Another is that the amount of *attraction—gravitational pull*—depends on the mass or weight of both particles. Large objects such as Earth, have great mass and therefore great gravitational pull. Finally, the greater the distance between the centers of objects or masses, the less gravity's force.

To push the Space Shuttle away from Earth's pull you need tremendous power. Engineers provide this with five huge powerplants, three engines on the Shuttle itself, and two in the form of solid rocket boosters. When these five powerplants burn huge quantities of propellants very quickly they provide forces that counter gravity and project the Shuttle into orbit.

The two solid rocket boosters are the largest ever flown: they're 150 feet high, half as high as a football field. Filled with over two million pounds of solid fuel, they weigh more than two-and-one-half-million pounds. To overcome gravity, they develop some five million pounds of thrust and push the heavy Shuttle 24 miles into space. Yet they burn up in only two minutes! To escape Earth's gravity their start-up speed must be phenomenal: they burn at full operating pressure in just half a second. And how hot and fast are the counter forces so the Shuttle can escape Earth's pull? The exhaust gases coming from the cones are over 6000°F and exit at 6000 MPH!

Once they separate from the Shuttle and stop burning, in spite of their size, heat, and speed, the solid rocket boosters use large parachutes to counter gravity's downward pull. *At less than 70 MPH they fall into the ocean where ships recover them.* On land, technicians refill them with solid fuel for new Shuttle flights.

The Shuttle craft itself has three large engines developing more than a million pounds of thrust. Unlike the solid rocket boosters, the Shuttle engines burn for more than eight minutes. Also unlike the solid rocket boosters, the Shuttle engines burn *liquid fuels: hydrogen and oxygen.* Their burn temperature is the same, about 6000°F. But rather than separating from the Shuttle and falling to the ocean by parachute, they shut down and remain part of the Shuttle, landing with it.

The half million gallons of supercold fuel for the three Shuttle engines is stored in a giant 150-foot-high fuel tank to which both the solid rocket boosters and Shuttle are attached. The fuels are chilled below -290°F. Like the two rockets, this tank separates from the Shuttle and breaks up

in the atmosphere. Once in space, the Shuttle pilot uses two small engines to achieve orbit (approximately 172 miles above the Earth); the pilot can also maneuver from one orbit to another, rendezvous with other objects, and leave orbit. With another series of very small engines (44 in all), the Shuttle captain can alter orbit speed and change the Shuttle's attitude (pitch, roll or yaw).

The five powerplants allow the 200,000-pound Shuttle to escape Earth's gravitational pull. If the Shuttle and rocket engines were smaller, Earth's pull would be less. But smaller engines wouldn't achieve break-away from Earth's gravity. So scientists and engineers balance size and engine power.

In orbit another kind of balance comes into play. Once in orbit, the Shuttle can stay there because of its speed, 17,500 MPH. With balance between its speed and the Earth's gravitational pull equal, the Shuttle rotates around the Earth every 90 minutes. It's then that the astronauts begin to experience *near-zero gravity*. Then they and everything else in the Shuttle that isn't fixed begin to float as if *weightless*.

The everyday experiences with gravity disappear: objects no longer fall from ceiling to floor; food angles off plates; sleepers float from their cots; tools wander off workbenches; fluids drift out of glasses. Everything must be secured, bolted or fixed in place. In this state, your body stretches about one inch taller and your waist also expands, because body fluids held in the lower portion of your body by gravity flow upwards in the absence of gravity. The astronauts must do their workouts strapped down on a treadmill to simulate the benefits of exercise they could normally gain from working against gravity.

Part of the training of astronauts is to learn to work in this weightless environment. Some training is done in a large over-sized swimming pool which simulates the type of effort required to work in space. This pool is approximately 70 feet long by 25 feet deep and large enough for the payload bay of the orbiter to fit inside it. A fully suited astronaut is placed under water and weighted so as to be neutrally buoyant. Under the water the astronauts practice functions that will have to be done while in space. Some training, such as using the manipulator arm to move large but weightless objects, is very hard to simulate.

Once in orbit, astronauts conduct experiments in the Shuttle to see what happens when Earth's gravitational force is almost eliminated (*it's about 1/nth of what it is on Earth*). For instance, how perfectly can honeybees make combs in these weightless conditions? Do the roots of plants sense in space which way the Earth's gravity would be pulling them so they'll grow away from their stalks? Can men, animals, insects and plants adapt to the weightlessness of space without danger or physical harm and remain productive on long space voyages?

At the end of the flight, using the Shuttle's smaller engines the pilot slows the craft down. Gravity then takes over, pulling the Shuttle back towards the Earth's tremendous mass. Without using engine power, the Shuttle is drawn back into the atmosphere, where it lands like a glider at about 200 MPH.

The goals of this lesson are to:

- Provide youngsters with an understanding of the basic principles of a natural force—gravity.
- Help youth explore the effects of gravity in their daily lives.
- Relate to youngsters how gravity affects the Space Shuttle on Earth and in orbit.
- Demonstrate how forces of one kind are used to balance others through complex teamwork.

Relationships to Other 4-H Projects

Piggyback Projects

- *Computer science*: how to quickly process large amounts of complex information and data.
- *Electronics*: how electric energy is used for Shuttle systems, such as in guidance, monitoring, control and communications.
- *Environmental education*: how gravity affects Earth's surface and plant growth; how man deals with the effects of gravity in daily living.
- *Career education*: career identification and exploration in a variety of fields, such as aeronautics, oceanography, mathematics.

■ *Citizenship International*: the need for programs like the Space Program and how they will affect people of the world.

■ *Safety education*: how to prevent accidents in threatening environments.

Discussion Questions

1. **What are three basic principles of gravity?**

   1: Every particle, no matter how small, attracts every other particle. 2: The amount of attraction—gravitational pull—depends on the mass or weight of both particles. 3: The greater the distance between the centers of objects or masses, the less the pull of gravity.

2. **How is gravitational pull affected by the mass or weight of an object? By distance?**

   (See "Three Principles" above.)

3. **What effects does gravity have on our daily lives?**

   The force of gravity pushes down on the Earth and we have to push back or overcome the force of gravity in our daily lives. Gravity makes lifting heavy objects difficult; holds heavy unfixed objects in place; and causes tides in coastal areas.

4. **What are the effects of gravity on the Space Shuttle? On Earth? In orbit?**

   Gravity gives the Shuttle weight on Earth and allows it to stand upright on the launch pad. In orbit, gravity's absence (only ⅙th Earth's gravity) causes near-zero weightlessness.

5. **How does gravity affect what we do?**

   Walking–We must lift our heavy arms and legs.

   Climbing–We must lift our entire body weight.

   Sitting–Holds people in place.

   Sleeping–Holds people, including arms and legs, in bed.

   Standing–Keeps people from floating in air.

   Rolling over–Holds you down until you reach an anticipated spot.

   Riding in a car–Keeps passengers in their seats.

6. **How much energy do you use to overcome the force of gravity each day? A little? A lot?**

   Only a little; astronauts use somewhat more energy in space than on Earth because of "floating" instead of "walking."

7. **When does Earth's gravitational pull completely disappear?**

   Never! Earth's gravity extends through the solar system but, for example, nearer another planet its gravity is counterbalanced by the gravity of the other planet.

8. **What are some problems the astronauts could face at near-zero gravity in Earth orbit?**

   Holding down objects–Objects float in space.

   Sleeping–Sleepers float, arms float away from the body.

   Eating–Food doesn't stay in place.

   Moving about with feet and arms–Astronauts must "swim" rather than "walk."

   Using tools–Tools don't stay put, they float.

   Storing materials and objects–They must be fixed in place or they will float.

   Using liquids–Liquids float out of containers, unless tightly sealed in special containers.

9. **How big are the rocket boosters on the Space Shuttle? What fuels do they burn?**

   Rocket boosters are 150 feet high and burn solid fuels.

10. **Why are rocket boosters needed?**

    On liftoff, they help the Shuttle overcome the initial strongest pull of Earth's gravity.

11. **Why are the rocket boosters so large?**

    To overcome gravity, they develop some five million pounds of thrust and push the heavy Shuttle 24 miles up into space.

12. **Why are the three main liquid fuel engines needed on the Shuttle? How similiar are they to the rocket boosters?**

    The main engines and the boosters help propel the Shuttle into space. The liquid fuel engines start burning

at the same time as the rocket boosters. The rocket boosters burn for only two minutes before being jettisoned and eventually drop back to Earth. The liquid fuel engines burn for eight minutes before shutting down, and they stay with the Shuttle throughout its flight.

13. What effect does gravity have on the jettisoned rocket booster engines? How do parachutes overcome these effects?

Gravity pulls the booster engines back to Earth. Parachute wind resistance slows their rate of fall so they do not disintegrate.

14. What parts of the Shuttle are reusable?

All parts except the liquid fuel tank are reusable.

15. Why does the Space Shuttle have so many different size engines?

Different sizes of engines are required to maneuver in different gravitational situations.

Basic Information on Food and Nutrition

Nutritious food, exercise and rest are important in keeping healthy on Earth and in space. Just as the Shuttle burns propellant (fuel) to lift off, the body burns food energy (fuel) to go and grow. Food contributes energy (measured in calories) and nutrients which bodies need for good health and growth.

Astronauts use a lot of energy working in a weightless environment in Shuttle orbit. You also use energy. When just sitting around you burn about 100 calories an hour. When you do moderate activity, such as walking fast, you use about 200 calories an hour. When you exercise vigorously, such as playing tennis, dancing or running, you use 350+ calories per hour. The more active you are, the more calories you burn. And, the less active you are, the fewer calories you need.

One aspect of keeping physically fit is regulating the intake of calories to guarantee you don't have more than you need. To lose weight, you can reduce the calories you eat *and* burn off excess calories to lose more weight. To gain weight, you can increase your calories.

Nutrients are more complex than calories to understand. You need more than 40 different nutrients for good health. The key nutrients are proteins, carbohydrates,

fats, vitamins, minerals and water. You also need them in the right amounts to remain healthy.

There's also a link between nutrients and calories. And it's an important one. Some foods provide more nutrients for the same amount of calories than others. A doughnut, for example, has the same amount of calories as three slices of bread. But the bread is richer in vitamins and minerals.

Everyone requires nutrients and calories. As growing youngsters, youth need to be very concerned about getting the nutrients and energy needed to build strong bodies and to help them go and grow. Many foods have information on their labels which tells the number of calories and the amount of protein, fat, and carbohydrates in each serving. Comparing labels to buy the most nutritious food is one step to good nutrition.

Another is knowing enough about nutrients to make wise food decisions. Good sources of protein—to build and repair tissue and muscles—are meat, milk, beans and nuts. Good sources of vitamin A—to promote healthy eyes and skin and also help in resisting infections—are fruits and vegetables. Fruits and vegetables are also good sources of vitamin C—it strengthens blood vessels, keeps teeth and gums healthy, and speeds healing.

Vitamin D-fortified-milk and fish are good sources of vitamin D which helps build strong bones and helps with natural growth. Vitamin B1 (thiamin) helps develop a healthy nervous system, appetite, and aids in digestion. The best sources of vitamin B1 are meats, grains, breads and cereals.

Two especially important minerals for youth are calcium and iron. Milk and cheese provide calcium for strong bones and teeth. Meats provide iron for blood development and energy.

Most foods contain a number of nutrients in varying amounts, yet there is no "perfect" food which contains all the nutrients in the "right" proportion. Therefore, it is important to eat a variety of foods and maintain a balanced diet.

In space, astronauts eat basically the same nutritious diets they'd eat on Earth, but because of the extra effort needed in the Shuttle, they simply eat more. Just like youngsters on Earth—for instance, young athletes—they eat more when they exert extra effort.

Astronauts exercise more carefully in space than on Earth. And the dietitians who plan their meals take precautions to assure them all the nutrients and calories they need to remain healthy during space flight.

However, foods are processed and packaged differently for space flight. The crew compartment on the Shuttle is small and there's little room for food storage. Foods in grocery stores are too bulky and heavy for space flight, so NASA processes the food before it is put into the Shuttle. Although food can be cooked in space the Shuttle doesn't yet have any refrigeration. But it does have water to replace the water that's removed during processing.

Several processing methods can be used: *Freeze-drying*—removing ice by vaporizing it, a method often used on vegetables such as corn. Or it can be simply *dried*—dehydration—as with soup mixes, cereals and meats. *Thermostabilization*—cooks and then seals foods, such as tuna fish, fruits, puddings and applesauce, in aluminum cans or flexible packages. The *intermediate moisture process*—for dried foods such as raisins and fruits. *Irradiation*—preserves breads and meat so they don't need refrigeration. Some foods, such as crackers, nuts and gum go aboard just as they are.

The Space Shuttle has a special food preparation area where astronauts prepare meals for eating, mostly by adding water (rehydration) and heating. Crew members can enjoy eating anywhere they want to and in just about any position—sitting, squatting, floating or hanging. However, they usually attach themselves to an anchor, such as a chair, the ceiling, a wall or a corner of the Shuttle. Specialized pouches and containers are used to keep food from floating freely in weightlessness.

The Shuttle program has taught many things about how to process, package and store lightweight, nutritious foods for long voyages. But the principles of good nutrition remain the same—for youngsters and astronauts—on Earth or in space.

The goals of this lesson are to:

- Teach youngsters the fundamental concepts of the relationships between food, nutrition and health.
- Help youth understand the importance of regular exercise.
- Impress upon youth the need for certain food nutrients for proper growth and development.
- Show similarities in the relationships between good food and nutrition requirements on Earth and in space.
- Identify various methods of food processing and show how they affect the foods we eat here on Earth and in space travel.

Relationships to Other 4-H Programs

Piggyback Projects

The food and nutrition segment of Blue Sky relates to several other 4-H projects. Blue Sky can be used to enrich or enhance learning experiences for these programs:

- *Agriculture*: Explore where to grow crops on Earth's surface and suitable environments for growing crops.
- *Career exploration*: the variety of careers in the food industry.
- *Computer science*: discover the many processes of storing, analyzing and retrieving data; how to make comparative selections; and maintaining food inventories and budgets.
- *Consumer and food economics programs*: how to choose the most nutritious foods for your needs and dollars; how to go about making decisions.
- *Food preservation and safety*: how foods are processed, packaged, handled and stored.
- *Health & fitness fairs and camps*: study the elements and importance of good nutrition; sources of food nutrients; functions of nutrients; the relationship between exercise, food and fitness; and food preparation.
- *International programs*: how nutritional requirements are beir around the world in different cu how different diets across the w provide nutrition for people; sh cross-cultural differences in eati patterns, styles, diets and food ch
- *Plant science and gardening*: h gravity affects plant growth; som techniques being used to grow

Discussion Questions

1. **What are proteins and what they do?**

   Proteins are the body's "buildir blocks" that aid growth and help disease. They are found in chee meat, fish, nuts, grains and dried and peas.

2. **What are some of the more important vitamins and mine**

   Vitamins A, C, D and the B vitam thiamin, riboflavin and niacin; minerals—calcium and iron.

3. **Why do we need calories fr food?**

   Our bodies require energy for maintenance, functions and gr

4. **What nutrients are found in following foods?**

   Eggs, liver, fortified milk, saltwa [vitamin D]

   Cheese [calcium and protein]

   Meat [protein and iron]

   Citrus fruits [vitamin C]

   Dark yellow or green leafy ve [vitamin A]

   Whole grain or enriched cere [vitamin B1—thiamin]

   Candy and carbonated bevera [mostly calories]

5. **What nutrients does milk c**

   Protein, calcium, riboflavin, fa lactose.

6. **How many calories an hour burn in various activities?**

   Sleeping—80; studying—150; walking—250; working hard–

7. **How many calories do you a normal day?**

   About 2,500.

8. How do you know if you're getting enough calories to meet your needs?

Use a calorie counter and information on food labels to run a check.

9. What key nutrients help you develop the following healthy body characteristics?

Strong bones and teeth ..... calcium, vitamin D

Growing tissues and muscles ..... protein

Blood supply and energy flow ..... iron

Healthy teeth and gums ..... vitamin C

Nervous and digestive systems ..... vitamin B1 (thiamin)

Good eyes and skin ..... vitamin A

10. What useful information does nutrition labeling on food packages provide?

Food labels give serving size, servings per container, calories, and percentage of the U.S. Recommended Daily Allowance amount for selected nutrients, such as protein, carbohydrates, fats, vitamins and minerals.

11. Describe how each of these methods of *food processing* works.

Thermostabilization–preserving food with heat and sealing the container, as in canning tuna fish, fruits, puddings, applesauce.

Dehydration–removing water from food, such as drying fruit.

Freeze-drying–removing ice from frozen food by vaporization, a method often used on vegetables.

Drying–same as dehydration, as with soup mixes, cereals and meats.

Irradiation–subjecting food to high energy rays to prevent decay, as in preserving bread and meat so they don't need refrigeration.

Intermediate moisture process–for drying foods, such as drying grapes into raisins, and other fruits.

12. What are some of the factors you need to consider when you make food choices?

Taste–How good does it taste?

Enjoyment–Do you like eating it?

Cost–Is it a good food value for the nutrients it provides?

Nutritional value–Does it provide significant amounts of one or more nutrients?

Balanced diet–How does it fit into a day's meal plan?

Ease of preservation and use–Can it easily and safely be stored until used?

Ease of preparation–Is it easy to prepare?

Quantity needed–How much will you need?

13. What factors are considered in the pricing of food?

Growing the food–Costs of land, farming, harvesting.

Advertising–Costs of promoting and marketing products.

Processing–Is the method for processing it complex and costly?

Delivery/transportation–Is the food shipped long distances? Does it have to be refrigerated?

Availability and season–How common is the food in your area? Can it be grown locally or does it have to be shipped in? Is the food in season?

14. Think of examples of each of the following types of newer foods:

Powdered foods and beverages–citrus drinks

Compressed food–food and cracker cubes

New food packaging–retort pouches, aseptic packages, new lightweight containers

Food coating to eliminate crumbs–cookies, snacks

Irradiated foods–fruits and vegetables, meats, scrambled eggs

15. What's the relationship between exercise and nutrition?

Exercise builds strong bodies and burns calories; it also helps the body absorb nutrients.

16. Think about a typical day's diet. How do you make certain you're getting a balanced diet?

Use the daily food guide as a standard. Run a check every once in

a while to see if you're eating a variety of foods from the various food groups in the proper amounts or serving sizes.

17. Why do astronauts eat the same balanced diets that you eat on Earth?

Astronauts are human beings and they have the same physiological needs for energy and adequate nutrition while in space as they do on Earth.

18. Why do youngsters have to be as concerned about balanced diets as astronauts do?

In addition to maintenance of bodily health and functions, youngsters must provide for rapid body growth.

19. What is eating in space like?

The process of eating is somewhat more difficult because of weightlessness or near-zero gravity. Foods must be packaged in special containers and fastened down to keep them from floating in space. The astronauts can eat comfortably while sitting down, lying down, floating or in most any position due to the weightless environment.

20. What two methods do astronauts use most in food preparation in space?

Rehydration and heating.

21. What challenges do a lack of refrigeration present to the Space Shuttle astronauts?

Many foods we are used to eating fresh from the refrigerator or from the freezer must be processed and prepared in different forms to provide balanced diets.

22. Why is food research important?

Food research helps assure an adequate long-term supply of food and helps us learn more about what nutrients are available and needed.

23. How will food research play a role in the ability to staff space stations for long periods in the future?

New ways of growing, processing and packaging foods are critical to how long man can stay out in space. The more abundant the food supply, the longer man can survive in space. Current research suggests that it will be necessary and possible to grow animals and insects in space to provide food.

24. How much do you think foods will change in the future? Will most of the changes be in new methods of processing or do you think there will be very different new food products? Explain why.

Foods will change very slowly in the future. Most of the changes will be in new methods of processing. We will see some new food products but not many because development of new products proceeds very slowly.

25. What kinds of teamwork does it take to develop new foods and food products for space use?

Scientific knowledge, packaging and engineering skills, and environmental information all can play a role.

QUESTIONS AND ANSWERS ON IRRADIATED FOODS*

Q. How does irradiation affect food?

A. It depends on the dose, the food, and the "targeted" organisms in the food. For example, low-dose irradiation is strong enough to inactivate microscopic trichina larvae that may be present in raw pork. But it's not strong enough to destroy many other disease-causing bacteria and spoilage organisms. Therefore irradiated pork does not have an extended shelf life. On the other hand, low-dose irradiation is strong enough to slow the ripening and aging of fruit, and to prevent harm from insects. Thus, irradiated fruit does have an extended shelf life. Approved radiation doses do not change the way foods taste.

Q. What irradiated foods are in the store right now?

A. Some processed foods contain spices that may have received high-dose irradiation. Irradiation was done to protect the spices from insects and microorganisms during bulk storage, before they were added to foods. Dried enzymes, such as rennet used in cheese-making, may also receive high-dose irradiation. FDA approved these uses of irradiation in the early 1980s. (In the 1960s, FDA approved low-dose irradiation to control insects in wheat and wheat flour, and to inhibit sprouting in potatoes. However, irradiated forms of these products are not in stores because food processors did not find irradiation commercially practical.)

Q. Are irradiated foods as nutritious as non-irradiated foods?

A. Having no evidence that low-dose irradiation significantly affected the nutrient constituents of food generally, FDA tentatively concluded that foods irradiated at low doses will have the same nutritional value as comparable food that has not been irradiated. USDA plans to study the possibility of vitamin loss in pork irradiated at low doses.

It is known that under certain conditions, high-dose irradiation can result in a loss of some B-vitamins such as thiamin. But the only foods likely to be irradiated at high doses in the near future are foods such as spices, which we eat in small amounts for flavor—not for vitamins.

Q. Where can I get more information about food irradiation?

A. For information about FDA's regulatory actions on irradiation, phone: (202) 245-1144.

For information about irradiated pork, phone USDA's Food Safety and Inspection Service at (202) 447-9913.

For general information about food irradiation, write Food Irradiation Information Center Coordinator, National Agriculture Library, Room 304, Beltsville, MD 20705. Phone (301) 344-4368.

SOURCE: Adapted from "Q & A: Irradiated Food at the Supermarket," In: ***Food News for Consumers, USDA***, Spring 1986, page 15.

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* **NUTRITION PERSPECTIVES**, May/June 1986

NEWS CLIPS

FOOD IRRADIATION, WHAT'S TRUE, WHAT ISN'T

You've heard a lot about food irradiation recently, but all you've heard isn't true.

Food irradiation is the exposure of food to ionizing radiation either from radioactive cobalt, cesium, or devices that produce electrons or X-rays.

You may have heard that it is an unsafe process. That it changes food to toxic compounds, that it is radioactive and glows in the dark, or that it promotes the nuclear arms race. These statements are false.

In 1981 the World Health Organization (WHO) concluded that irradiation is a safe food treatment. The U.S. Food and Drug Administration (FDA) agrees that irradiated foods are safe. In 1986 the FDA approved irradiation to control insects and microorganisms on spices, to control insects on fruits and vegetables and to extend their shelf life, and to control Trichina on raw pork. The American Medical Association, the American Council on Science and Health, The Council for Agricultural Science and Technology, and hosts of scientists from Universities agree that the treatment approved is safe.

The problem with irradiation is the name. It sounds scary. But really the treatment is comparable to other familiar food treatments, like cooking. For example, when something is irradiated, chemical changes take place and food molecules are rearranged; when you bake something, like bread dough, chemical changes take place and food molecules are rearranged. When you take the irradiated food from the irradiator, it is changed, but safe to eat. When you take the bread from the oven, it is also changed, but safe to eat.

Similarly, what is safe for your food, may not be safe for you. If ***you*** go into an irradiator which was turned on, chemical changes would take place in your body cells and you may die. If you went into an oven set for 350 degrees F, chemical changes would take place in your body and you would also die.

Irradiation critics cite outdated, poorly designed experiments or irrelevant data to generate doubt about the safety of this process. They raise consumer anxiety and then ask for donations to continue their "protection" of the public interest.

Today, most people recognize that everything has some degree of risk. The key is relative risk. Irradiated foods are safer than foods treated by some fumigants. They are also safer than foods contaminated by certain molds or microorganisms. Astronauts eat irradiated foods while in space. Hospital patients who require food without contamination eat irradiated foods. Recognized health officials consider irradiated foods safe for general consumption.

Submitted by: Christine M. Bruhn, Consumer Food Marketing Specialist
Source: ***CAST Ionizing Energy in Food Processing and Pest Control: Wholesomeness of Food Treated with Ionizing Energy.*** July 1986.

NEWS CLIPS

FOOD IRRADIATION: WHAT'S IN IT FOR YOU?

Why should you care if irradiated food ever reaches the supermarket? Because of safety and quality.

Irradiation is the exposure of food to ionizing radiation either from radioactive cobalt or cesium or from devices that produce electrons or X-rays. It can be used to kill insects or bacteria which may be on food or to extend the shelf life of food.

Some insect quarantine treatments are of minimal effectiveness or use chemicals that are known carcinogens. Irradiation kills insects by rearranging a few molecules, yet it leaves no chemical residue on the food and does not effect the food's safety.

Irradiation is an effective insect control on all fruits, even those where no other treatment works. It permits safe transport of any foods from an insect quarantine area. If irradiation is used, new specialty tropical fruits may be introduced into local markets. The quality of existing fruits like mangoes and papayas may be improved because irradiation results in a better quality fruit than current quarantine treatments.

Since irradiation rearranges molecules, it can increase the shelf life of some fruits and vegetables. For example, it slows cell metabolism and keeps potatoes and onions from sprouting so quickly. It also slows mold growth, so oranges, strawberries and raspberries may last a bit longer. When dried fruit is irradiated, insect eggs and larva are destroyed. The fruit is more tender and absorbs water more easily.

From a health standpoint, the greatest advantage of irradiation is the destruction of harmful microorganisms. Bacteria is everywhere. When it is allowed to grow, by not washing and sterilizing carefully enough at home, or not keeping cold foods cold or hot foods hot, bacteria can cause illness. Public Health officials estimate that the two most common food related illnesses, caused by salmonella and campylobacteria, affect more than 4 million Americans annually. These illnesses cause discomfort, but among the very old, very young or the weak, they can cause death. Irradiation of beef and poultry would destroy these bacteria and reduce these food borne illnesses. These products have not been approved by the FDA yet, but there is a petition now requesting that irradiation of poultry be permitted.

Irradiation has been used in Japan since 1970 to extend the shelf life of potatoes used in chips. It has been used in several countries to improve the hygienic quality of spices. In South Africa it is used to extend the shelf life of tropical fruits, and in the Netherlands to control salmonella in shrimp and frog-legs.

In the United States, irradiation is proceeding slowly because of uncertainty about consumer demand. Irradiated mangoes were enthusiastically bought by consumers in Florida in the fall of 1986 and irradiated papayas were preferred by customers in Southern California in March, 1987.

Irradiated foods will be labeled with words like, "irradiated" or "treated with radiation" and the international logo. Some people prefer to eat foods which have been treated as little as possible. Others would prefer to select irradiated foods to experience the advantages the process offers.

Submitted by: Christine M. Bruhn, Consumer Food Marketing Specialist
Source: ***CAST Ionizing Energy in Food Processing and Pest Control: Wholesomeness of Food Treated with Ionizing Energy.*** Microbial Pathogens in Raw Pork, Chicken and Beef: Benefit Estimates for Control using Irradiation. T Roberts. American J. of Ag. Economics, Dec. 1985.

NOTE: If you wish to borrow this set of books for your ***Blue Sky Below My Feet*** camp or after school program, contact Marilyn Townsend, Youth Development Specialist, Nutrition Education.

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WHAT ARE THE BENEFITS OF FOOD DEHYDRATION?

By Daniel F. Farkas, Ph.D

A food that's shriveled, flavorless, and sometimes hard as a rock? Doesn't sound very appetizing, but that's a temporary—and highly economical—condition for dehydrated foods.

Dried foods are structureless, lightweight, and nonspoilable. They can be packaged, shipped, and stored for dollars less than their fresh counterparts. And when water is re-added they pop back into shape and regain most of their original color, flavor, texture, and nutritive value as well. From the time that man first began to hunt and gather—to go from seasons of plenty to seasons of none—dehydration has been an important method of saving foods from microbial spoilage. In many Third World countries today sun drying is still the only ready means of preserving momentary surpluses of food crops. Dried potatoes, for example, are an important staple in Peru; dried fish in India.

In other parts of the world, foods are shipped great distances and the most important benefit of dehydration is reduced costs for handling, distribution, packaging, and food service.

But even inexpensive foods must taste good. Food preservation methods, such as canning and freezing, have established high levels of quality for processed foods. To successfully compete in the market place, dehydrated foods must be high quality. The dehydration industry must pay great attention to the color, flavor, structure, nutritive value, and functional properties of the rehydrated product. And the water removal must be accomplished as quickly and gently as possible—a vast change from old processing methods, such as sun drying and smoke curing.

Sun dried cod fish and smoked, salt-cured meats are not of much interest to people in the United States today. New freeze drying, intermediate moisture, air-dryed, or dehydro-frozen food processing techniques have presented the U.S. consumer with food items of high nutrient value, convenience, and acceptability. From milk to coffee, pasta, potato chips, and jam, the dehydration process plays an important role in our diets today.

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PREVENTS FOOD SPOILAGE

Dehydration is an effective way to preserve foods from microbial spoilage. Microbes, like all life forms, require water for growth and reproduction. Dried foods cannot support the growth of microbes. But microbial spores, like seeds, may remain dormant and ready to grow when moisture is returned to the food.

Oxygen can also cause major changes in the color, flavor, and nutrient values of dried foods —particularly because of the porous structure of these foods. Oxygen can enter into direct chemical reaction with fats, pigments, and vitamins in foods.

The less water a food contains the less likely it is to support any microbial growth. But dehydrated foods are not entirely devoid of water. The humidity a food maintains around itself in a sealed package at a constant temperature is called its "water activity." Water activity is related to the moisture content of the food by the chemical composition of the food.

At high moisture contents the relative humidity surrounding the food is 100 percent. As moisture is removed by the dehydration process the water activity is reduced. At a relative humidity of 65 percent no microbial growth (bacteria, molds, or yeasts) can occur.

Unfortunately, enzymatic and chemical reactions continue at this low moisture level. Other preservation methods must be used in conjunction with drying to prevent enzyme and chemical caused quality loss. Heat, chemical antioxidants (such as sulphur dioxide), and packaging are frequently used together to provide an efficient barrier to moisture, light, and oxygen. Low temperature storage is also sometimes combined with dehydration in a process called "dehydro-freezing."

Often a number of preservation techniques must be used to produce the desired dried food. For example, carrots to be used in an instant dry soup mix may be heat treated with steam to inactivate enzymes and microbes, dried to a moisture content in equilibrium with 40 a percent relative humidity, treated with a chemical antioxidant, and carefully packaged (in a nitrogen environment) in a steel can.

The canned dried carrots might then be held under refrigeration prior to repackaging in a soup mix. The retail envelope is likely to contain aluminum foil so that the envelope can be flushed with nitrogen before sealing. This ensures an oxygen-free storage environment.

While reducing humidity to 65 percent stops all microbial growth, bacteria are so sensitive to water loss that their growth is halted when only 20 percent moisture is removed (80 percent humidity). Only molds and yeasts will grow at the 65-80 percent humidity level. This is called the "intermediate moisture" region.

Intermediate moisture foods retain many of their original functional properties. But foods preserved at this moisture level must be further processed to inactivate or inhibit the growth of molds and yeasts.

Molds and yeasts, however, are quite heat sensitive. After pasteurization with a mild heat treatment their growth can be prevented by generally recognized as safe (GRAS) preservatives. These include sorbic acid or sodium benzoate. This process is used for intermediate moisture foods: fruit preserves, jams and jellies, processed cheese, high moisture dried fruits, and many bakery items.

The removal of water from foods is an extremely complex process. Ideally, each molecule of water should be taken from the food so that on rehydration another water molecule will exactly replace it without changing the color, flavor, or structure of the original food.

Achieving this kind of precise dehydration imposes quality limitations on food preserved by drying. The complexities of water removal have resulted in a wide range of dehydration methods. Industry uses various methods to achieve an optimum water removal rate for foods of many forms, such as juices, pastes, flakes, chunks, and whole pieces.

HOW DEHYDRATION WORKS

Dehydration is a process of evaporation. Heat from the surrounding air provides the energy necessary to evaporate water in the food. In all dehydration processes the food is surrounded by an environment relatively warmer than the food until the last molecule of water evaporates. The hotter the environment surrounding the food, the faster the rate of water evaporation. Unfortunately, heat can damage the flavor, color, and structure of foods. Successful dehydration technology therefore depends on careful control of temperature.

Freeze drying is the most effective method for preventing heat damage during dehydration. The process known as sublimation—evaporation of water directly from the ice state—is the basis of this method. Frozen foods of all types are suitable for freeze drying.

The frozen foods are placed in a sealed chamber on heated plates and air is evacuated from the chamber to the range of one thousandth of an atmosphere. (One atmosphere is 14.69 pounds per square inch.) At this pressure water evaporates directly from ice to vapor. The heat provided by the plate is regulated to match the heat needed for evaporation so that the frozen food does not melt.

Freeze drying provides the highest quality of all the dehydration processes. It has been used to preserve microbes, even to restore water soaked books or paper or other artifacts. But it is an expensive process. First the food must be frozen, then the water sublimed in the vacuum chamber must be trapped and refrozen as pure ice. Because of this double freezing step and vacuum system, freeze drying is used where no other form of dehydration will work.

Freeze dried products are high quality—they are porous, sponge-like, and rehydrate quickly. Freeze dried coffee, for instance, has the best flavor of all dried coffees. Freeze dried meat, vegetable, and pasta products make instant soups, sauces, and gravies possible. Complete "quick cooking" (hot water reconstitution) meals for

"The removal of water from foods is an extremely complex process. Ideally, each molecule of water should be taken from the food so that on rehydration another water molecule will exactly replace it without changing the color, flavor, or structure of the orginal food."

backpacking are also made from freeze dried components.

A new dehydration technique developed by the U.S. Army's Natick Laboratory combines microwave processing with freeze drying and compression. Together these methods greatly reduce the size of the final product. They squeeze a can of peas into a teaspoon, for instance. Unfortunately, the high cost of this complex method means that foods dried this way are feasible only when space is a real premium, as in submarines and spacecraft.

Vacuum drying is a less costly adaptation of freeze drying. It is the workhorse process for the concentration of liquids prior to freeze or spray drying. Vacuum drying allows water to boil or evaporate at temperatures near room temperature. Milk, tomato paste, coffee, orange juice, and many other foods are concentrated or dried under vacuum.

Vacuum concentration can, however, cause the evaporation of volatile flavors as the water is removed. For this reason many flavorful liquid foods such as orange or apple juice are subjected to a process called essence stripping. In this process the volatile oils are quickly flash evaporated at the start of the concentration process. The volatile flavors are trapped as a separate concentrated essence fraction and are returned to the concentrated product after the water is removed. Frozen concentrated apple and orange juice are popular examples of this process.

Conventional air drying is carried out by placing food on an endless perforated stainless steel belt and passing warm air alternately up and down through the bed of food. Sections of the moving belt may be housed in a drier component several hundred feet long. Initially water evaporates rapidly from the food, cooling the bed of particles by evaporative cooling. As drying continues the bed of particles shrinks in proportion to the water lost. In addition, the temperature of the bed of food rises since less water is available to cool the product. At this point the food may be repiled in a deep moving bed.

Thousands of tons of onions, potatoes, and various cut vegetables are dried by conventional air drying. Most of the vegetables are used as ingredients in other products, such as celery and green peppers for canned stewed tomatoes, potatoes for corned beef hash, onion pieces for salad dressings. However, outside the U.S., high quality air dried vegetables are competing well with canned and frozen products as convenience foods.

The process of spray or drum drying at atmospheric pressure is used for liquids and pastes. In these processes the liquid is formed into a fine spray of droplets or a very thin film. In these forms, warm air (spray drying) or a hot surface (drum drying) causes water to evaporate almost instantly and yields a very high quality dry particle. The quality of the product is preserved because water evaporation takes place in seconds with the evaporating water providing protective cooling.

Non-fat milk and instant coffee are examples of spray dried foods. Mashed potato flakes and quick cooking or "instant" hot cereals are often drum dried. During drum drying the sheet of food comes off the drum dryer looking like tissue paper. The product is then collected, ground to flakes, and packaged.

Some foods are dried in the course of other types of processing. For example, baking and deep fat frying are drying processes. The crust of a loaf of bread acts as a moisture barrier that protects the interior of the loaf from spoilage. Deep fat fried snack items have a low moisture content, and when properly packaged to keep out oxygen, can have a long shelf life. Cold cereals are dried and toasted, cooled, and packaged to retain their low water activity, flavor, and crispness.

CONCLUSION

Consumers are becoming familiar with the advantages of "instant" or quick cooking dried foods: their convenience, compactness, low storage costs, and variety. The food industry is endeavoring to meet consumer needs with new dehydrated products. Instant soups are a good example of the success of new items. Sauces, rice, and potato products have also met the challenge of their fresh, frozen, and canned counterparts.

The ancient method of sun drying has come a long way. Today's hungry teenager can just add water to a cup full of noodles, meats, and vegetables, place the cup in a microwave oven for two minutes and presto! A nutritious after school snack.■

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